# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

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**JUNE 1925.**

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## GENERAL PHYSICS.

**1279.** *Some Effects of the Atmosphere upon Physical Measurements.* **E. W. Washburn.** (Science, 61. pp. 49–56, Jan. 16, 1925. Address delivered before the Am. Assoc. for Advancement of Science, Washington, Dec., 1924.)—The address is devoted to a consideration of certain effects of the physical atmosphere which sometimes result in causing an investigator to be under the delusion that he is measuring or utilising one quantity when, as a matter of fact, he is dealing with something, not greatly perhaps, but still appreciably different, and discusses weighing, thermometric vapour-pressure, boiling-point, specific heat, latent heat, density, viscosity and solubility determinations. E. G.

**1280.** *Densities of Certain Aqueous Potassium Chloride Solutions as determined with a New Picnometer.* **H. C. Parker** and **Elizabeth W. Parker.** (J. Phys. Chem. 29. pp. 130–137, Feb., 1925.)—A modified Sprengel type of picnometer, here described, eliminates the difficulty and error introduced by the necessity of filling to an exact volume. The volume occupied by the liquid can be read to within 4 parts per 10,000,000. Determinations, made at 0° with an accuracy of about 1 per 1,000,000, of the densities of potassium chloride solutions containing 0·099271, 0·1, and 0·01 equivalents of the salt per cubic decimetre give the respective values 1·004840, 1·004881, and 1·000372 grammes per c.c., the value 0·9998406 being taken for water at 0°. The errors inherent in the picnometric measurement of densities are discussed. With a quartz picnometer of the authors' design an accuracy of 1 part in 25,000,000 should be attainable. T. H. P.

**1281.** *The Determination of the Density of Rock-Salt Crystals.* **W. Geiss.** (Ann. d. Physik, 76. 4. pp. 403–408, Feb., 1925.)—The density of rock-salt is of great importance, since it is customary to base the wave-lengths of X-rays and the lattice constants of other crystals on this substance. The author has determined the density of some very fine, clear, flawless crystals by weighing in air and in benzol, and finds by taking the mean between his values and those of Baxter and Wallace the value $2\cdot1644 \pm 0\cdot05\ \%$ at $18\cdot0°$ C. For the relation between the temperature and the density he finds $\rho t = 2\cdot1644[1 - 0\cdot000121(t - 18\cdot0)]$; the linear coefficient of expansion is $\alpha = +40 \times 10^{-6}$; the lattice constant of rock-salt at temperature $t$ is $d_t = 2 \cdot 81400\ [1 + 0 \cdot 000040(t - 18 \cdot 0)]$. H. N. A.

**1282.** *Specific Gravity of Mercury.* **K. Scheel** and **F. Blankenstein.** (Zeits. f. Physik, 31. 1–4. pp. 202–209, 1925. From the Reichsanstalt.) —The mean value at 0° C. is 15·59546. Two different samples of mercury gave 15·59540 and 15·59558. The specific gravity at temperatures $t$ from 0° C to 100° C. is

$$15 \cdot 59646 \left\{1 + \left[18 \cdot 182 \frac{t}{100} + 0 \cdot 078 \left(\frac{t}{100}\right)^2\right] 10^{-3}\right\}$$

A. D.

**1283.** *Meteorological Instruments and Apparatus employed by the United States Weather Bureau.* **R. N. Covert.** (Optical Soc. of America, J. and Rev. Sci. Inst. 10. pp. 299–425, March, 1925.)

**1284.** *On the Use of the Eötvös Balance for Large Masses which are Near Together.* **K. Mader.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 3–4. pp. 117–132, 1924.)—The second type of Eötvös balance is here investigated after a brief description of an earlier variety. The two weights concerned are suspended in two different equilibrium positions, and the system so formed is very rigidly treated by the author entirely from a mathematical standpoint. The formula for the turning moment, which was derived by Eötvös on the assumption of a linear force field, is found to hold good when very large masses are near together, the total error being less than $1 \cdot 10^{-9}$.

H. H. Ho.

**1285.** *A Rapid-Weighing Torsion Balance.* **Research Staff of the General Electric Co., London.** (Journ. Sci. Instruments, 2. pp. 119–124, Jan., 1925.)—A direct-reading torsion balance for sorting according to weight the spiral filaments used in the manufacture of gas-filled lamps is described. Its capacity is 70 milligrammes. An inherent error in this type of balance is investigated theoretically. AUTHORS.

**1286.** *Ultramicrometer applied to the Microbalance.* **R. Whiddington** and **F. A. Long.** (Phil. Mag. 49. pp. 113–121, Jan., 1925.)—The most sensitive microbalances hitherto made are those of Steele and Grant, Ramsay and Gray, and Petterson [see Abstract 1983 (1909)]. In all cases, however, great sensitiveness has been obtained only at the expense of the maximum load and the general robustness of the apparatus, and the smallest change in weight measurable was of the order one ten-millionth of the total load. In each case the balance proper was made entirely of fused quartz, and enclosed in an airtight case, so that small changes in weight might be either compensated by or compared with the effective change in weight of a small air-bulb, produced by altering the pressure in the case. Deflections of the beam were optically observed. The first two were supported by knife-edges, while the last was suspended by two very fine quartz fibres. In this last case, as Petterson suggests, the limit of fine working seems to be imposed by the smallness of tilt which can be measured optically. Thus finally the problem may be resolved into the measuring of an extremely small distance, namely that moved through by the end of the beam. The present paper deals with the application of the ultramicrometer [see Abstract 1350 (1920)] to a balance of the Petterson type. The results obtained almost reach the measurement of a change of $10^{-9}$ gm. in a load of 0·2 gm. But practical difficulties make the operation less simple than was anticipated. E. H. B.

**1287.** *Micrometers and Measuring Instruments.* **P. Duckert.** (Zeits. Instrumentenk. 44. pp. 443–453, Oct.; 483–494, Nov., and pp. 547–555, Dec., 1924.)—A description, with numerous illustrations and diagrams, of various types of micrometers. For a comprehensive treatment of the theory of the various instruments the author refers to the treatise by E. Becker in Valentiner's *Dictionary of Astronomy*, vol. 3, Sect. I. E. F.

**1288.** *A Gyro-Compass incorporating Two Gyroscopes.* **J. B. Henderson.** (Phil. Mag. 49. pp. 273–283, Jan., 1925.)—This paper contains the mathematical analysis of the motion of a two gyro-compass in which both gyroscopes are meridian-seeking, all torques being continuous functions and the interaction of the two gyroscopes providing mutual damping. It is shown how the two periods of oscillation may be calculated and how the conditions for their mutual damping may be obtained. The undamped periods of the compass described are 120 and 12 mins. in lat. 51°. The unstable gyro has 10 % greater angular momentum than the stable one, and both long- and short-period oscillations are damped to 0·2 % in 120 mins. The compass settles on the meridian with both rotor axes horizontal, provided that weights are placed on the north end of the stable and south end of the unstable gyros sufficient to produce the precession $\omega \sin \lambda$, the velocity of the meridian about the vertical. H. H. Ho.

**1289.** *Cambridge Stress Recorder, Collins' Patent.* (Journ. Sci. Instruments, 2. pp. 131–135, Jan., 1925.)—The instrument described records rapidly or slowly varying stresses in bridges or other structures due to moving loads. Permanent records of small dimensions are obtained on transparent celluloid by the action of a stylus which moves in accordance with the extension or compression of the structural member to which the instrument is attached. Microscopic examinations or photographic enlargements of the records can be readily made. A number of actual records are reproduced. AUTHOR.

**1290.** *Acoustic Relative Velocity Indicator for Aeroplanes.* **A. de G. de Guiche.** (Comptes Rendus, 179. pp. 1591–1593, Dec. 29, 1924.)—An apparatus with very small inertia is described, with a duralumin propeller 9 cm. in diameter, weighing only 10 grammes, and an alternator with fixed coil and permanent magnet, in which the revolving keeper is quite light and runs in ball-bearings. The method of construction is ingenious, but the original paper should be consulted for the details. One of these small wind-propelled alternators may be mounted at the tip of each wing, and when they are connected to the two telephones of a headpiece worn by the aviator the sounds produced will, with practice, give by their relative pitch and intensity a means of estimating the direction and intensity of gusts of wind before they can influence the equilibrium of the machine. The apparatus is particularly adapted for use with gliders. H. N. A.

**1291.** *The Relation between Diffusion Velocity, Viscosity and External Pressure.* **E. Cohen** and **H. R. Bruins.** (Zeits. phys. Chem. 114. pp. 441–452, Jan. 20, 1925.)—A determination is made of the rate of flow of mercury through a glass capillary in a suitable vessel mounted in a steel enclosure. The Poiseuille formula is applied for the calculation of the viscosity, and due allowance is made for the relative compressibilities of glass and mercury in determining the height of the mercury column and its density under the applied pressure. It is found that at a temperature of 20° C. and under an external pressure of 1500 atmos. the viscosity is increased by 4·8 %. It is estimated in earlier work on the influence of pressure on the rate of diffusion of cadmium in mercury that at a pressure of 1500 atmos. the value is increased by 5 %. It is therefore concluded that the product of diffusion velocity and viscosity is constant and independent of external pressure [see Abstract 987 (1923)]. J. N. P.

**1292.** *The Determination of Surface Tension from the Rise in Capillary Tubes.* **S. Sugden.** (Am. Chem. Soc., J. 47. pp. 60–64, Jan., 1925.)—Richards, Speyers and Carver, in a recent paper, refer to the equations of Rayleigh for very narrow and very wide tubes, and state that the problem has not been solved mathematically for the intervening region [Abstract 1978 (1924)]. The author calls attention to his paper of 1921, in which the tables of Bashforth and Adams are used to fill this gap. These tables depend on the determination of the surface of revolution about a vertical axis for a liquid in equilibrium under the forces of capillarity and gravity. The numerical solutions of the equation are obtained by rigid mathematical reasoning. Rayleigh's formula gives values which are too low by 1 part in 400 when $r = 2\cdot4$ mm. for water, while the author's tables give the correction for tubes up to 18 mm. in diameter with an accuracy of 1 point in 3000 parts or more. H. N. A.

**1293.** *Measurements of Velocities in Liquids.* **L. Escande** and **M. Ricaud.** (Comptes Rendus, 179. pp. 1590–1591, Dec. 29, 1924.)—The chronophotographic method of determination, using powders, is not successful when the motion of the liquid becomes turbulent, since particles passing any point are oriented differently. Spheres of 2 to 3 mm. diameter, of the same density as the liquid, integrate the velocity of the particles in contact with them, so that they have the mean velocity of the water at each point; they follow mean trajectories, and their velocity can be easily measured by means of chronophotography. In an experiment with a nozzle, with turbulent flow, a Pitot tube gave 1·4 m./sec., while the spheres gave 1·39. The theory of the Pitot tube is considered, and a method is described which makes it more sensitive for small velocities. Rateau remarks in a note that the integration produced by the small spheres will only be satisfactory if their diameter corresponds to the size of the eddies which cause the turbulence. H. N. A.

**1294.** *Measurement of Capillarity and Friction Coefficients of Viscous Fluids.* **Emma Müller.** (Akad. Wiss. Wien., Ber. 133. 2a. No. 3–4. pp. 133–147, 1924.)—A new method is described by means of which the capillarity constant and frictional coefficient of a viscous liquid may be found sumultaneously. The liquid is sucked up a capillary tube to a height above the equilibrium position, and is then allowed to fall. The rate of fall depends on both the capillarity constant and the friction coefficient, and observations of the rate of fall enables both quantities to be found. The method was applied to a series of glycerine-water mixtures. A. W.

**1295.** *The Examination of the Elastic Properties of Rubber, Steel and Other Materials.* **L. Hock.** (Zeits. techn. Physik, 6. 2. pp. 50–58, 1925.) —A brief survey of various methods used for elasticity measurements is given, and in particular the case of rebound is considered. An apparatus is devised, described, and used for the estimation of the elasticity of rubber, steel, etc., by the rebound and range of a small sphere dropped from a definite height and incident on the material under test at various angles. The steel, etc., lies on a massive base, and the sphere is projected over a definite range by the rebound. This is utilised as a measure of the elasticity of rebound of the material. The end of the sphere's trajectory is recorded by its point of impact on a strip of blue paper. The order of the elasticity of various materials can thus be measured as a percentage of the energy of falling of the sphere. By means of a cathetometer the height of the trajectory of the sphere is observed as well as the range. The theoretical consideration of the apparatus is fully treated, and it is shown that the elasticity cannot simply be worked out from the range length alone, as the rotation of the sphere, etc., have to be considered in strict mathematical reasoning. The mathematical theory, however, can be used for this apparatus, and tables showing experimental results are given. S. G. B.

**1296.** *Elastic Deformation of Thick Plates.* **C. A. Garabedian.** (Comptes Rendus, 180. pp. 257–259, Jan. 26, 1925.)—The author gives calculations showing how, from his solution of the problem of the elastic deformation of a uniformly loaded, contour-supported, rectangular thick plate, the other three cases of primary importance to the engineer—*viz.* that of a centrally loaded supported thick plate and those of a uniformly loaded and a centrally loaded rectangular thick plate with the contour fixed (in grooves)—may be obtained. The author points out that these four solutions are exact analogues of the solutions given in an earlier paper [see Am. Math. Soc. Trans. 25. pp. 379–388 (1923)] for circular thick plates. **Errata** (*ibid.*, p. 1191, April 14, 1925). G. W. de T.

**1297.** *Adhesives and Adhesive Action.* **J. W. McBain** and **D. G. Hopkins.** (J. Phys. Chem. 29. pp. 188–204, Feb., 1925.)—Qualitative and quantitative examination, including tensile and shear tests, are made of a large variety of adhesives and materials. A joint between porous materials—such as wood, unglazed porcelain, pumice, and charcoal—is obtained with the majority of recognised adhesives. This adhesion is of a mechanical nature, and results from the solidification of the material *in situ* to form a solid film embedded in the pores. In a further type of adhesion, shown by polished glass, fused silica and smooth metals, a specific interaction is involved between the smooth non-porous surface and the adhesive, which may be chemical or adsorption or mere wetting. A joint appears to result in all cases from a liquid which wets a surface and is then solidified. The very strong metal-adhesive joints obtainable under suitable conditions support Hardy's theory of specific interaction to account for lubrication. Although gelatin and glue adhesives, including highly purified ash-free gelatin, are by far the strongest for wooden joints, there is no evidence of any specific interaction, such as adsorption with wood, filter-paper or viscose. Gelatin is adsorbed by fused silica, and unites smooth silica surfaces. Silicate of soda used between walnut surfaces exhibits a sharp maximum strength at the composition $Na_2O \cdot 3SiO_2$.

This maximum is by no means so pronounced with glass surfaces, but occurs at approximately the same composition. The thinnest films yield the strongest joints, provided that complete contact is maintained with the surfaces. Most adhesives join smooth metallic surfaces, and even soft pliable shellac yields joints withstanding 2 tons to the square inch.

J. N. P.

**1298.** *The Strength and Elastic Limits of Natural Rock-Salt.* **A. Joffé** and **M. Lewitsky.** (Zeits. f. Physik, 31. 7–8. pp. 576–583, 1925.)—Contrary to results obtained by H. Muller (Phys. Zeits. 25. p. 223, 1924) and Polányi and Ewald [Abstract 8 (1925)], the authors find that the strength of natural crystals of rock-salt is independent of the cross-sectional area of the crystal. The increase of strength found by Müller in the case of crystals of small cross-sectional area is attributable to previous treatment of the crystals with water, which may produce after-effects persisting for as long as twenty-four hours. The conclusion reached by Ewald and Polányi that the increased strength of crystals under water is attributable solely to lowering of the elastic limits and consolidation of the crystals by plastic deformation is disproved, as the tensile and compression elastic limits were found to have a constant value equal to about 920 grm./sq. mm., irrespective of the origin of the sample and the presence or absence of any effect due to water. A sample which in water maintained a load equal to 4000 grm./sq. mm. without fracture broke when dry when the applied load was equal to 450 grm./sq. mm. For flexural stresses the temperature of transition from the brittle to the plastic state of the crystals is approximately atmospheric. [See Abstract 1994 (1924).] J. S. G. T.

**1299.** *The Forces at the Ends of a Vibrating String.* **W. H. George.** (Phil. Mag. 49. pp. 97–106, Jan., 1925.)—The forces at the ends of a vibrating string, due to the tension of the string, are discussed as regards magnitude and frequency. The increase in tension due to change of shape whilst vibrating as related to length is calculated. Theoretical determinations and numerical calculations are made for the maximum tension for a given amplitude, and the results referred to pianoforte strings. The effect of inclination of the vibrating string upon the longitudinal and normal forces at the ends of the string is shown graphically. The longitudinal component of double frequency is shown by calculations of the horizontal and normal forces for steel wires of different characters. Reference is made to Barton, Raman, Berry, and other workers as supporting the above results. Finally, the anomalous occurrence of the $n$th partial created by striking a string $\frac{1}{n}$th of its length from the nearer bridge is discussed. S. G. B.

**1300.** *Logarithmic Decrement of a Pendulum.* **D. Bean.** (Zeits. f. Physik, 29. 6. pp. 360–366, 1924.)—If the period of a pendulum remains constant, then the logarithmic decrement should be constant, since the resistance to motion is proportional to the velocity. But experiment shows that the logarithmic decrement varies with the amplitude, and this variation is greater than can be explained by the change in period with change in amplitude. The change in period with change in amplitude of 0·125 radians is only 1/1000, while the change in logarithmic decrement is very considerably greater. The change in logarithmic decrement with change in amplitude was measured, using a special pendulum; this had four rectangular slabs mounted on it, so that they could be rotated singly about the pendulum shaft, so as to present either an edge or a face to the direction of motion without moving up or down the pendulum. For a particular arrangement of these slabs the change in decrement was more than 100 %, while the change in period was less than 0·1 %. By altering the orientation of the slabs, it was found that the logarithmic decrement was proportional to the moment of surface (area × distance squared). A. C. M.

**1301.** *Fluid Circulation round Cylindrical Obstacles.* **Dorothy M. Wrinch.** (Phil. Mag. 49. pp. 240–250, Jan., 1925.)—A discussion of the motion of a fluid outside a fixed cylindrical obstacle in the presence of one or more line sinks or sources when there is circulation round the obstacle. The problem of the presence of a single sink is dealt with initially in detail, and the resultant pressure on the obstacle found by evaluation of the contour integral $\int_c (dW/dz)^2 dz$, where $W = \phi + i\psi$, and $\phi$ is the velocity potential and $\psi$ the stream function associated with the motion. The problem is next treated for a source and a sink, and when their positions are suitably chosen this gives, as a degenerate case, the problem of fluid streaming past and circulating round a cylindrical obstacle. A contour integration along $c$ (the curve of cross-section of the obstacle) yields the result that the force on the obstacle per unit length is $\rho kq$ in a direction at right angles to the direction of the undisturbed stream measured in the opposite sense to the circulation, where $\rho$ is the density of the fluid, $k$ the intensity of circulation, and $q$ the velocity of the undisturbed stream. The paper is mathematical throughout, and concludes with the aerodynamic significance of the results. S. G. B.

**1302.** *Turbulent Motion.* **S. Mohorovičić.** (Zeits. techn. Physik, 6. 2. pp. 68–74, 1925.)—New fundamental formulæ for turbulent motion in fluids possessing internal friction are derived. These are applied to turbulence in a circular pipe, and the results are in almost complete agreement with observation. Moreover, transition states between turbulent and laminar motion can be obtained on this theory. W. A. R.

**1303.** *Cinematographic Measurements of the Downward Motion of Spheres in a Viscous Fluid and also in Close Proximity to a Wall.* **H. Liebster** and **L. Schiller.** (Phys. Zeits. 25. pp. 670–672, Dec. 15, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Recent Göttingen experiments [see Abstract 1936 (1922)] have established the character of the resistance coefficients for the sphere in the region of the Reynold numbers ($R = vd/\nu$, $v$ = velocity, $d$ = diameter, $\nu$ = kinematic viscosity) $10^3$ to $10^6$, and the present paper supplies data for the smaller R values from 0·04 to $10^3$ by means of a cinematographic method applied to falling spheres. The data are important for testing the recent Oseen theory. Experimental details, with data and curves, are included for steel spheres moving through glycerine, sugar solutions, and water. The concluding part of the paper deals with the influence of the wall of the experimental vessel upon a sphere moving parallel and in close proximity to it. H. H. Ho.

**1304.** *The Equivalence of Fluid Friction in Pipes and Tractive Losses for Trains.* **A. Talon.** (Comptes Rendus, 180. pp. 43–45, Jan. 5, 1925.)—Recent work, particularly of Stanton and Pannell, has established that the resistance to flow of a fluid in a smooth pipe when the flow is turbulent, R, is given by a form: $R/\rho U^2 = \alpha + \beta/(UD/\nu)^{0\cdot35}$, where U is the velocity, D the diameter, $\nu$ the kinematic viscosity, and $\rho$ the density; $\alpha$ and $\beta$ are constants over the range of velocities dealt with. The formulas proposed for the resistance of trains are very diverse. They are mostly variants on the form $K + \lambda U + \mu U^{\times}$, but for different formulas there is no similarity between these coefficients. The curves are similar in form, and may all be represented by forms like the fluid formula given. It is suggested that there is a real connection between the two cases, since the train will carry with it a sheath of air which will set up a zone of turbulence. The value of K expressed in kilos. per ton (metric) will be equivalent to a loss of head in the fluid motion. A. Wh.

**1305.** *Impact of Solid Bodies with Liquids.* **G. E. Bell.** (Phil. Mag. 49. pp. 451–456, Feb., 1925.)—The continuation of work described in an earlier paper [Abstract 12 (1925)]. The shadows of the splashes made by bodies of various shapes and coated with different substances are studied in the light of a rough theory of the forces acting on the liquid in the immediate vicinity of the impinging body. If the surface tension of the liquid is high and the body is quite clean, only a small disturbance is produced, while if the surface is contaminated with oily matter any disturbance which may be produced is intensified. Bodies with flat noses or flat on the back always leave cavities in the liquids into which they fall, and these cavities become large when there is contamination of their surface. A. Wh.

**1306.** *Oblate Spheroidal Harmonics and their Physical Applications.* **J. W. Nicholson.** (Roy. Soc., Phil. Trans. 224. pp. 49–93, Feb. 8, and pp. 303–369, Nov. 13, 1924.)—In a brief introduction the author points out that the harmonic functions appropriate to the oblate spheroid, which are of the form $p_n(\zeta)$, $q_n(\zeta)$, or $P_n(\iota\zeta)$, $Q_n(\iota\zeta)$, where the capital letters denote the usual Legendre functions, have received but little attention, except C. Niven's 1886 Phil. Trans. paper, which has little to do with these memoirs. The author develops an extensive anaylsis with far-reaching applications to problems, which in many cases are new. In other cases geometrical methods leading to serious limitations have hitherto alone been effective. The analysis is shown to be closely related with other methods, such as the Fourier-Bessel integral method. A general solution of the problem of a three-dimensional source of fluid on the axis of a circular obstacle is obtained. The remainder of the first memoir is mainly concerned with applications to electrical problems, such as: A charge $+e$ is on the axis of an oblate spheroid or circular disc kept at zero potential; to find the potential at any external point, and the charge induced. An infinite plane conductor at zero potential contains a circular hole, on the axis of which is a charge E; to find the distribution on the conductor. Potential of a circular ring in a spheroidal harmonic series: A thin electrified ring is coaxial with an oblate spheroid; to find the charge induced on the spheroid when at zero potential. Other problems dealt with are the relation between aperture and disc problems in electrostatics and hydrodynamics, and, given a source on the axis of a circular aperture in an infinite plane wall in an infinite liquid, to find the discharge of liquid through the aperture. The second memoir is devoted mainly to the problems of the electrification of two parallel circular discs and the necessary extensions of the analysis for their treatment—systems of more than two discs and of unequal discs. G. W. DE T.

**1307.** *The Motion of a Material Particle under the Attraction of a Flat Ellipsoid.* **P. Fatou.** (Comptes Rendus, 180. pp. 366–368, Feb. 2, 1925.)—The motion of a particle under the attraction of a flat ellipsoid, such that the momental ellipsoid is a surface of revolution and the potential at a distant external point $(R, \phi)$ is given by $\mu/R + k(1/3 - \sin^2\phi)/R^3$, is very briefly discussed. J. S. G. T.

**1308.** *The Stabilisation of Unstable Equilibrium by Means of Gyroscopic Forces.* **H. J. E. Beth.** (Phil. Mag. 49. pp. 447–450, Feb., 1925.)—It is shown mathematically that the stabilisation of unstable equilibrium having an even number of degrees of instability is always possible by means of gyroscopic forces satisfying certain conditions which are deduced. J. S. G. T.

**1309.** *The Notion of the Variation of Mass deduced entirely from the Formula for the Addition of Velocities.* **H. Malet.** (Comptes Rendus, 180. pp. 425–427, Feb. 9, 1925.)—A particle of mass $m_0$ moving with a velocity $v$ enters a longitudinal field F. According to classical mechanics its velocity in time $dt$ is increased by $Fdt/m_0$. Hence applying the formula for the addition of velocities we have $v+dv=(v+Fdt/m_0)/(1+vFdt/c^2m_0)$, whence $dv = F(1 - v^2/c^2)dt/m_0$. The apparent longitudinal mass $m$ of the particle is therefore $m_0/(1 - v^2/c^2) = m_0/\lambda^2$. Taking account of the relativity of time intervals, it is shown that $m = m_0/\lambda^3$. In a transverse field F the velocity of the particle becomes $\sqrt{v^2 + \lambda^2(Fdt)^2/m_0^2}$. Assuming the conservation of time, it follows that the particle has an apparent transverse acceleration $F\lambda dt/m_0$, whence it follows that the apparent transverse mass of the particle is $m_0/\lambda$. The same result follows when the relativity of time is taken into account. J. S. G. T.

**1310.** *Two Methods of Calculation available in the Quantum Theory for the Calculation of Perturbations.* **W. Woltjer, Jr.** (Zeits. f. Physik, 31. 1–4. pp. 107–111, 1925.)—Particulars are given of two methods available for the solution of the system of partial differential equations occurring in astronomical mechanics in the canonical form $dx_i/dt = \partial F/\partial y_i$, $dy/dt = -\partial F/\partial x_i$, $(i = 1 \ldots n)$, where F can be expanded in powers of a parameter $\mu$ so that $F = \Sigma F_p\mu^p$, the series being such that $F_p$ is a periodic function of the variables $y_1 \ldots y_n$, having a period $2\pi$, when $p \geqslant 1$, and $F_0$ is a function of $x_1 \ldots x_n$. The one method of solution depends upon a suitable choice of solution of the corresponding Hamilton-Jacobian partial differential equation; the other method is due to Delaunay, and employs a series of canonical transformations. [See Abstract 1955 (1922).] J. S. G. T.

**1311.** *Dimensional Analysis.* **N. Campbell.** (Phil. Mag. 49. pp. 284–285, Jan., 1925.)—The author points out, in reply to E. Buckingham's criticism [see Abstract 2668 (1924)] of his paper [see Abstract 1059 (1924)], that he did not cast, and would never think of casting, the smallest doubt on the value of Rayleigh's use of the argument from similarity, but does deny that this and the highly important work of the Aeronautics Staff of the N.P.L. has anything to do with "dimensional analysis," as expounded by E. Buckingham and others. The insistence on dimensions and the neglect of similarity is the direct cause of the errors to which he drew attention—in fact, he would go farther, and maintain that the concept of dimensions is totally useless, and, in view of its dangers, should be abandoned. It was introduced originally to describe how the numerical value of a magnitude would change with the units employed in measuring it, on the assumption that the formal constants of the laws defining the magnitudes would always remain unaltered. Experience has shown that the assumption is untrue; physicists often find it convenient to change the formal constants rather than the numerical value. Moreover, units are now so standardised that the results of any change that ever occurs can be and are tabulated in detail; there is no need to consider how they can be deduced. The use of dimensions in checking an equation by examination of the dimensions of its two sides has also proved worthless, for equations which do not satisfy the criterion can be found in the writings of the most eminent physicists. G. W. de T.

**1312.** *Quantum Dynamics of Degenerate Systems.* **A. M. Mosharrafa.** (Roy. Soc., Proc. 107. pp. 237–246, Feb. 2, 1925.)—For degenerate conditionally periodic systems the quantum restrictions are suggested to be of the form $Y_j = \tau_j h$, where $Y_j$ is a particular adiabatic invariant. An application to the Stark-effect for the hydrogen atom is given, and the adoption of half-integral orbits is demonstrated. The results are consistent, and it is suggested that fractional quantum numbers arise in the mechanism of such systems. A. Wh.

**1313.** *Rhombic, uniformly Rotating Systems in Electronic Dynamics.* **U. Crudeli.** (Accad. Lincei, Atti, **33.** ii. pp. **401–404**, Nov. 16, 1924.)—The model proposed by Bohr for the neutral hydrogen molecule represents a rhombic system endowed with a uniform rotatory motion, but with the plane of the rhombus passing through the axis of rotation. The author's object is to demonstrate the existence and structure of uniformly rotating rhombic Rutherford-Bohr systems, each one situated in a plane at right angles to its own axis of rotation. The treatment is entirely mathematical. E. F.

**1314.** *The Valency of Boron.* **R. C. Ray.** (Indian Chem. Soc., J. 1. pp. 133–139, Dec. 31, 1924.)—Boron is trivalent in its halogen derivatives and in most of its other compounds. In a number of compounds, however, it is pentavalent, and structural formulæ are given to illustrate this for $C_6H_5 . B . Cl_4$, $(CH_3)_3B : NH_3$, $C_2H_5(C_2H_5O)_2B : B(OC_2H_5)_3$, and a number of other substances, including the hydrides, in which the group $\vdots B : B \vdots$, which appears to be a fairly stable one, occurs. According to Bohr's theory, the boron atom consists of the helium structure of two electrons in uni-quantum orbits, and in addition three electrons in two quantum orbits of type **2**; these three electrons can each "share the outer ring of three halogen atoms, thus completing their octets." On the other hand, five additional electrons can gather round the boron atom (in two-quantum orbits), completing the octet; this will give a negative valency of five. The Lewis-Langmuir theory of fixed electrons leads to similar results, and is made use of mainly by the author, as it is more suitable for graphical representation. It is suggested that the reason that no compound $BH_5$ exists is that a neon system of electrons round the B nucleus, with the five H nuclei arranged externally, would be unstable on account of the mutual repulsion of the numerous H nuclei. Such a repulsion is indicated in the values of the mean collision area of various gaseous hydrides calculated by Rankine from viscosity measurements. H. N. A.

**1315.** *Quantum Defect and Atomic Number.* **D. R. Hartree.** (Phil. Mag. 49. pp. 390–396, Feb., 1915.)—This paper is a criticism of a paper by L. A. Turner [see Abstract 28 (1925)], in which the latter proposed an alteration of the assignment of principal quantum numbers to certain terms of atomic number greater than 28. Hartree's conclusion is that, not only is there no demand for the proposed alteration, but further that, at any rate in most cases, Bohr's quantum numbers for terms corresponding to those orbits which penetrate the core are definitely correct.

G. W. de T.

**1316.** *A Redetermination of the Atomic Weight of Bromine. The Inseparability of the Isotopes by Fractional Crystallisation.* **P. L. Robinson** and **H. V. A. Briscoe.** (Chem. Soc., J. 127. pp. 138–150, Jan., 1925.) —The total number of crystallisations made was approximately 2700, and in this way a head fraction (most soluble) and tail fraction (least soluble) were separated. The atomic weights of these two fractions were determined by precipitating with silver nitrate, and were found to be practically identical, the mean of the two values being 79·914 ± 0·010. There was thus no separation of the isotopes and no real difference in solubility between the two fractions. The result is compared with that obtained with the hexahydrated nitrates of lanthanum and neodymium; the molecular solubitities are 0·46520 and 0·46515, but in spite of this about 1600 crystallisations as double ammonium nitrates and about 1300 as simple nitrates produced a number of fractions of neodymium free from appreciable traces of other earths. In ammonium bromide hydrogen and nitrogen together form less than 20 % of the salt, and the two isotopes $Br^{79}$ and $Br^{81}$ are present in nearly equal proportions, and differ by 2·2 % in atomic weight. The fact that they are not separated in the above experiments supports the theories of Bohr and of Bury, which assume that the additional electrons in the atom of the heavier of a pair of rare earth metals are less intimately associated with the corresponding protons than are the additional electrons in the heavier of a pair of isotopes. H. N. A.

**1317.** *Structure of Fatty Acids. X-Ray Analysis.* **G. Friedel.** (Comptes Rendus, 180. pp. 409–411, Feb. 9, 1925.)—Remarks relative to a note on this subject by J. J. Trillat [Abstract 1006 (1925)]. The author's views on the "smectic" and crystalline structure of fatty acids and soaps are defined; the meanings given by Trillat to "smectic," crystalline and amorphous states are criticised, as well as his conclusions relative to observations on the structure of palmitic acid at different temperatures.

A. B. W.

**1318.** *Modification of Crystal Forms by Foreign Matter dissolved in the Mother Liquor.* **P. Gaubert.** (Comptes Rendus, 180. pp. 378–380, Feb. 2, 1925.)—The modification of the shapes of crystals by foreign materials has been studied by coloured substances. The complex crystal is either a regular grouping of the two substances or a solid solution. A hypothesis is proposed to explain the modification of crystal form.

F. J. B.

**1319.** *The Crystal Structure of Some Binary Carbides and Nitrides.* **K. Becker** and **F. Ebert.** (Zeits. f. Physik, 31. 1–4. pp. 268–272, 1925.) —TiC, TiN, VC, VN, ScN, ZrC, ZrN, NbC, NbN and TaC crystallise in the cubical system, and all contain four molecules in the elementary cell. Whether the structure was of the rock-salt or the zincblende type was worked out for ScN, and it was found that the former structure gave intensities of the interferences agreeing with those observed, which was not the case for the latter structure. The lattice is an atomic one. MoC, WC and TaN do not possess cubical symmetry; their structure cannot be determined from the Debye-Scherrer diagrams obtained by the authors, though certain conclusions can be come to in the case of TaN. It is probable that both this nitride, which contains 6·9 % of N, and another containing 3 to 4 % produced by the heating of the tantalum wire in a nitrogen-filled incandescent lamp, consist of an irregular compound of unknown symmetry and a solid solution of $N_2$ in tantalum, the tantalum lattice being expanded by the addition of nitrogen. H. N. A.

**1320.** *The Lattice Theory of Distorted Ions.* **G. Heckmann.** (Zeits. f. Physik, 31. 1–4. pp. 219–223, 1925.)—M. Born has already suggested that many of the failings of the lattice theory may be due to deformation of the ions. The author takes up the suggestion, restricting himself, however, to regular diatomic molecules of the D-lattice (type NaCl, CsCl, and ZnS). The main facts of the theory are considered without great detail, and it is shown that distortion of the ions is essential for the explanation of the phenomena. The former rough statements could not produce the necessary calculations in a suitable way, and the influence of electronic configuration has to be taken into account. By these means the effects of long-wave radiation and dielectric and piezoelectric stimulations can be explained. R. S. R.

**1321.** *The Benzene Ring.* **E. Schröer.** (Zeits. Elektrochem. 31. pp. 53–54, Feb., 1925.)—E. and F. Müller (*ibid.*, 30. p. 493, 1924) having proposed a three-dimensional model based upon the electronic theory, the author briefly describes his own model. He assumes with Kossel attractive and repulsive forces and electrons distributed on shells. The model is of high symmetry and electric stability, and explains certain peculiarities of isomerism, hydrogenation, oxidation and compounds in which nitrogen replaces CH. H. B.

**1322.** *Chemical Affinity and Electronic Structure. Part I. The Non-Polar Bond.* **B. H. Wilsdon.** (Phil. Mag. 49. pp. 354–369, Feb., 1925.) —It is assumed that the free valency orbits of uncombined atoms must have identical or harmonically related frequencies before they can form a chemical bond. A change of frequency without a jump in the principle quantum number, may be produced by precessional rotations due to a magnetic field or to nutation due to an electrostatic field. Bonding brought about by a magnetic field will correspond to a non-polar combination, and by an electrostatic field to a polar one. It is possible to estimate the change in kinetic energy from a knowledge of the natural frequencies of uncombined atoms, and the heats of formation of non-polar compounds can be calculated. The available bond energy will only represent the change of kinetic energy on combination if no energy is used in distorting the molecule. The formation of the $H_2$ molecule is a case in point, and the heat of dissociation is calculated as 77·55 cal. Langmuir's value is 85, and that of Franck and Knipping 81. Similar agreements are found in the cases of Cl, Br and I. In the case of more complicated atoms, where the moment of the atomic trunk is not zero, it is possible to consider the distribution of energy as corresponding with what exists in the anomalous Zeeman-effect, and it has been possible to calculate the heats of dissociation of the halogen hydracids, oxygen, nitrogen, carbon and its compounds, and a number of trivalent compounds. H. N. A.

**1323.** *The Quantum Theory and the Formation of Molecules.* **M. Born** and **J. Franck.** (Zeits. f. Physik, 31. 5–6. pp. 411–429, 1925.)—When neutral atoms combine the theory is generally similar to the classical one, and little can be said about the probability of an electron spring taking place or of the electron springing back again. Even if the energy is not sufficient to ionise the atoms, no stable union takes place without a triple collision, since it is infinitely improbable that the quantum energy of the completed molecule should agree with the energy of the atoms, or that the quantified rotational impulse of the molecule should agree with the value of this quantity for the atoms. For a certain distance in the cometary orbits, during the time of collision, the electron system of the two atoms is the same as in real molecules. These are only distinguished from the former by the fact that radial motion and rotational impulse are quantified; hence the emission and absorption of light by two atoms during collision will take place in the same way as in a true molecule, but with non-quantified vibration and rotation; they can be spoken of as forming a "quasi-molecule." A number of spectral phenomena which indicate the existence of such quasi-molecules are discussed, including those in metal vapours. The question of the existence of chemical affinity between the atoms of the rare gases is considered; these show cohesion at very low temperatures. It is suggested that a condition is to be regarded as a case of unstable equilibrium when, with regard to the radial degree of freedom, no additional stationary quantum state, not even one quantum vibration, is possible. In such a case it is suggested there is no chemical affinity. H. N. A.

**1324.** *The Number of Free Electrons Within a Metal.* **E. H. Hall.** (Nat. Acad. Sci., Proc. 11. pp. 36–38, Jan., 1925.)—The author is of opinion that Boltzmann's equation, connecting the number of atoms and the number of free electrons with the work required to release an electron from an atom within the metal, should be limited to cases in which, apart from the influence of $\phi$, passage of a particle from state A to state B is neither more nor less difficult than passage in the opposite direction. The third law of thermodynamics does not seem to apply to the case of the free electrons within a metal; there appears to be an essential mechanical difference between the condition of the ions within a solid metal and that of ions in a liquid solution. The author has assumed, in framing a theory of electric conduction in metals, that the number of free electrons may in some metals be 2 or 3 % of the number of atoms at ordinary temperature. The ionising potential in many metals studied varies from about ⅛ volt in cobalt to about ⅓ volt in iron at 0° C., much smaller than the ionising potentials of the corresponding metal vapours.

H. N. A.

**1325.** *On the Momentum imparted to Electrons by Radiation.* **E. O. Hulburt** and **G. Breit.** (Phys. Rev. 25. pp. 193–196, Feb., 1925.)—Theoretical deflection of a beam of electrons by electromagnetic radiation.—Assuming (*a*) the theorems of conservation of energy and momentum, and (*b*) the agreement of the light quantum theory with the wave theory in their estimates of the radiant energy scattered in various directions from a beam of electromagnetic radiation by a group of electrons, it is shown that the total momentum transferred to the electrons is the same on both theories and that $\Delta v/v = (8\pi/3)(e^4/m^3c^4v^2)l\rho$, where $l$ is the distance travelled through radiation of density $\rho$, and $e$, $m$ are in e.s.u. Even under very favourable conditions $\Delta v/v$ is only about $10^{-14}l$, hence the deflection of the beam electrons would be too small to detect experimentally. In case only certain electrons are deflected, experimental arrangements such as are used to observe fish-tracks may make these visible. AUTHORS.

**1326.** *The Harmonic Analysis of Electron Orbits.* **F. C. Hoyt.** (Phys. Rev. 25. pp. 174–186, Feb., 1925.)—Harmonic analysis of penetrating electron orbits in the Bohr atom has been effected on the assumption that the outer segments of such orbits may be considered as parts of Keplerian ellipses and that the penetrating part of the orbit, which is traversed in a time short compared with the period of the Keplerian motion, may be represented arbitrarily as a continuation of the exterior motion. If the Fourier series is written in the form

$$x + iy = \Sigma(-\infty \text{ to } +\infty)\, C_r e^{2\pi i(r\omega + \sigma)t}$$

the formula for the amplitudes is

$$C_r = (a/2\pi)\sqrt{\sin^2(2\pi\sigma/\omega) + (\cos(2\pi\sigma/\omega) - 1)^2}\,\Sigma'(-\infty \text{ to } +\infty)\, b_m J_m(\rho\epsilon)$$

with

$$b_m = \{(1 + \epsilon^2)(\rho - m) + \epsilon'\}/\{(\rho - m)^2 - 1\} \\ - \{\epsilon\epsilon' + \tfrac{1}{2}\epsilon(\rho - m)\}/\{(\rho - m)^4 - 4\} - (3/2)\epsilon/(\rho - m)$$

where $a$ = major axis of the outer segment, $\sigma/\omega$ = ratio of frequency of precession to the frequency of Keplerian motion = $2\pi$ times angular separation of outer segments; $\rho = r + \sigma/\omega$; $\epsilon$ is the eccentricity of outer segment; $\epsilon' = \sqrt{1 - \epsilon^2}$. The J's are Bessel functions of the first kind. Tables are given of the values of $C_r$ for $\epsilon = 0{\cdot}3, 0{\cdot}6, 0{\cdot}866, 1$, and $\sigma/\omega = 0, \tfrac{1}{4}, \tfrac{1}{2}, \tfrac{3}{4}, 1$. The error involved in the method may be large for high order harmonics or small values of $\epsilon$. In the case of some orbits of sodium ($3_1$ $3_2$, $4_2$, and $5_2$) the calculated values of the main coefficients agree fairly well with values obtained by Thomas from spectroscopic data by the method of Fues. Applications of this analysis to intensity relations in spectra will be made in a later paper. A. E. G.

**1327.** *The Electrical Constitution of the Ether.* **M. le Besnerais** and **R. Ferrier.** (Comptes Rendus, 180. pp. 427–429, Feb. 9, 1925.)—The ether is considered to be composed of electrons, each of which is in motion with a constant velocity relative to its neighbours, so that the ether as a whole is characterised by a slow motion of dilatation. The specific indentive capacity of such an ether is unity, and transverse waves are propagated therein with the velocity of light. J. S. G. T.

**1328.** *Matter and Radiation.* **O. Lodge.** (Wireless World and Radio Rev. 15. pp. 610–617, Feb. 4, 1925. Engineering, 119. pp. 158–159, Feb. 6, 1925.)—The author reviews briefly the subjects of atomic structure, the production of radiation, photoelectricity, thermionics, radio-telephony, the possible interconversion of matter and energy, and the ether theory. Vision and the growth of vegetation are considered to be photoelectric phenomena. The author expresses doubt as to the possibility of the production of radiation by the mere change of *direction* of motion of an electron. The energy of matter is kinetic; that of the ether is potential. Energy passes continually from matter to ether and back again. The ultimate object of physics is to explain all material phenomena first in terms of electricity and magnetism and then these in terms of ether. The author suggests that the electron is an "ether vacuum," its electric charge just compensating etherial pressure and preventing collapse. J. S. G. T.

**1329.** *Quantum Theory.* **L. de Broglie.** (Ann. de Physique, 3. pp. 22–128, Jan.–Feb., 1925.)—The history of optical theories show that scientific thought long hesitated between the emission hypothesis and the wave theory; these two views are therefore without doubt less opposed than they appeared to be, and the development of the quantum theory seems to confirm this conclusion. Guided by the idea of a general relation between the notions of frequency and energy, there is introduced in the present mathematical paper a periodic phenomenon (of a nature to be hereafter defined) which connects any isolated quantum of energy and which depends upon its magnitude as expressed by the equation of Planck-Einstein. The theory of relativity leads then to an association between a uniform motion of a particle and the propagation of a certain wave of which the *phase* advances in space with a speed exceeding that of light. The principle of Fermat applied to the wave is shown to be identical with the principle of least action applied to a moving particle. The rays of light are identical with the trajectories possible to the particle. These ideas are then applied to the Bohr atom of hydrogen, consisting of proton and electron moving in circular orbits about their common centre of gravity. E. H. B.

**1330.** *On the Theory of Axially Symmetrical Einsteinian Fields.* **P. Straneo.** (Accad. Lincei, Atti, 33. ii, pp. 404–410, Nov. 16, 1924.)—Basing his investigations on previous work by Levi-Civita, the author attempts to obtain expressions for the Einsteinian gravitational equations for systems of masses symmetrically distributed about an axis. The greater part of the paper is taken up with discussion of the mathematical methods employed. In a future contribution he intends to give examples and examine the results obtained by various authors. E. F.

## LIGHT.

**1331.** *The Colours due to Thin Films on Metals.* **U. R. Evans.** (Roy. Soc., Proc. 107. pp. 228–237, Feb. 2, 1925.)—An experimental examination is made of the objections raised by Mallock and by Raman to the generally accepted view that the colours of thin films of oxide, sulphide and iodide on metals are due to interference effects. Mallock's failure to alter the colours of tempered iron by polishing the iron is ascribed by the author to uneven rubbing, the film being removed at some points and left intact at others. It is shown that the colours can be changed when the thickness of the film is uniformly reduced by kathodic treatment in dilute HCl. Raman's statement that the structure of the film is granular is disproved by obtaining the colours on lead, whether the oxide film is molten or solid. These oxide films were lifted off the lead and examined microscopically, but no granular structure was detected, while the colours by transmitted light were complementary to those by reflected light as required by the interference theory. Reference is made to recent work by Mason [Abstract 317 (1925)] and Gale. R. S. R.

**1332.** *The Physical Definition of the Colours of Bright Pigments.* **T. Oryng.** (Phys. Zeits. 26. pp. 185–187, Feb. 1, 1925.)—The colour perception theory of W. Ostwald was strongly attacked by K. W. F. Kohlrausch in 1920, and although O. Meissner replied to him, no complete answer has been as yet given to Kohlrausch's objections. Ostwald showed that to define pigment colours it is possible to use the three conceptions colour tone, white content, and black content, the amounts of these three constituents fixing the colour of the body investigated. It is, of course, possible instead of these three elements to use others, *e.g.* the colour tone, *Farbton*, the purity and the brightness; it is then necessary, however, to define the meaning of the term brightness physically, which is not very easy, as J. v. Kries has recently shown [see Abstract 815 (1925)]. The author is of the opinion that the facts can be more easily explained by means of the Ostwald theory; he proceeds to describe certain features of the theory, including Ostwald's assumption that bright pigment colours contain a certain proportion of black, which is the same for all the "cold" colours. O. Meissner has shown that the latter assumption is incorrect, and curves are given showing the black and the white contents of Ostwald's different colour tones as found by him. Various other difficulties in connection with the theory are pointed out. [See **E. Schrödinger** (*ibid.*, pp. 349–352, May 23, 1925).] H. N. A.

**1333.** *Absorption of Light and Quantum Theory.* **C. Bialobrzeski.** (Acad. Polonaise des Sci. et des Lettres, Cracovie, Bull. No. 1. 2a. pp. 21–28, Jan.–Feb., 1924.)—The paper is an attempt to show the possibility of accounting for the real absorption of short electromagnetic waves of the order of light waves, in accordance with the quantum theory, by the transformation into heat of the pressures exerted by the waves upon the molecules of the absorbing body, regarded as elementary resonators.

It is assumed that the laws of dispersion and propagation of the electromagnetic waves are entirely of statistical type. G. W. DE T.

**1334.** *A New Method of Examining the Interior of Pearls.* **B. Szilard.** (Comptes Rendus, 180. pp. 433–436, Feb. 9, 1925.)—The principle of the method which is here described in detail consists in observing the material immersed in a liquid which has a suitable index of refraction and strongly illuminated from below. The liquid prevents reflection by the surface. By the means employed it is possible to see directly in all the mass of the pearl; the image can be photographed and subsequently studied. Only those pearls with a nucleus of mother-of-pearl give special striations in the centre, and so these pearls can easily be identified. A. E. G.

**1335.** *The Relationship between Refractive Index and Pressure for Certain Organic Liquids.* **I. Eisele.** (Ann. d. Physik, 76. 4. pp. 396–402, Feb., 1925.)—F. Himstedt and I. Wertheimer [Abstract 472 (1923)] have carried out experiments on the influence of pressure on the refractive index of certain organic liquids and the author has used essentially the same method except for a slight modification, allowing the two sets of interference bands to be brought into greater proximity. Experiments have been made on $CH_3NO$, acetone, toluol, aniseed oil, $C_7H_8O$, $C_7H_7NO_2$, and $C_8H_{10}$, for which the results are given. Determinations have also been made of the refractive indices of these liquids, using the method of minimum deviation. The calculations made of the coefficient of compressibility, using formulæ by Beer, Newton and Lorentz, agree with those obtained by direct experiment. W. V. M.

**1336.** *Refraction of a Spherical Wave in a Spherical Interface.* **I. Roman.** (Phys. Rev. 25. pp. 550–557, April, 1925.)—The transformation of a plane or spherical wave by refraction at a plane or spherical surface is treated vectorially, and the vector equation of the refracted surface is calculated completely in each of the following four cases: (1) Plane wave incident on plane surface, (2) plane wave on spherical surface, (3) spherical wave on plane surface, and (4) spherical wave on spherical surface. In each case an exact expression for the longitudinal aberration is calculated, and this is reduced to the usual formula by expansion in series. AUTHOR.

**1337.** *Temperature Variation of Anomalous Reflection of Silver.* **M. de Sélincourt.** (Roy. Soc., Proc. 107. pp. 247–254, Feb. 2, 1925.)—By observing the shift of the band of weak reflection of silver (in the region about 3200 Å.) with temperature, the author endeavours to obtain information as to the mechanism responsible for this anomalous reflection. The experimental method consisted in photographing the spectrum from a tungsten filament lamp after causing the light to suffer reflection on its way to the spectograph by a silver surface whose temperature could be varied. The resulting blackening of the photographic plate was measured photoelectrically. The effect observed is of the order that would be expected if, (1) the electrons moved in sympathy with the heat vibrations of the atoms, or (2) they were controlled by the atoms themselves, though the latter view is scarcely tenable, as the ions must be presumed to carry a residual positive charge, which cannot well be imagined to repel an electron. F. S. B.

**1338.** *Depth Illusion in Pictures.* **A. Ames, Jr.** (Optical Soc. of America, J. and Rev. Sci. Inst. 10. pp. 137–148, Feb., 1925.)—Describes different methods of increasing the illusion of depth in a single picture, *viz.* (1) use of only one eye; (2) use of an iconoscope, by which the parallax effect in ordinary binocular vision is eliminated; (3) viewing from a considerable distance; (4) artificial alteration of the convergence of the eyes by the use of prismatic spectacles; (5) viewing through a small hole, some 2 mm. in diam., held close to the eye; (6) changing the eye accommodation by the use of lenses; (7) blurring of one image when binocular vision is employed; (8) viewing by reflection in a mirror; and (9) viewing under conditions of abnormal rotation of the visual images about the axes of vision. The best combination is that of (1), (4), (6), (7) and (8). The explanation of the effect is that the causes contributing to depth perception are of two classes, objective and subjective. In the former class are (*a*) scale or perspective, (*b*) known forms or relationships, (*c*) shadows, and (*d*) aerial perspective. The latter class includes (*e*) accommodation, (*f*) characteristics of the retinal image as regards diffusion, etc., (*g*) convergence, (*h*) the true parallax effect. The effect of the methods of producing depth illusion in a single picture is to eliminate the subjective causes, so that the objective causes have full play. Thus the sense of relief produced by such factors as scale, shadows and aerial perspective of a picture are not destroyed by the subjective factors, which convey the information that the object looked at, the picture, is plane. J. W. T. W.

**1339.** *Period of Undulation in Vision.* **N. Kleitman** and **H. Piéron.** (Comptes Rendus, 180. pp. 393–396, Feb. 2, 1925.)—Shows that the maximum time of undulation for the blue, observed by Broca and Sulzer and by Haas, was a rod effect. The general law connecting speed of establishment of the equilibrium sensation V with the intensity I is $V = a \log I + K$, where $a$ and K are constants. The values of $a$ are as follows: White, 4·6; blue, 6·8; green, 13; red, 15; blue (peripheral, *i.e.* rod), 27·3. J. W. T. W.

**1340.** *Notes on Some Diffraction Experiments.* **S. Ray.** (Phys. Rev. 25. pp. 208–210, Feb., 1925.—Three simple diffraction experiments.—(1) In the crossed shadow of a rod and a wire grating, in a beam from a point source, the shadow of the lines of the grating tend to become normal to the rod, the dark lines broadening and the bright lines narrowing down to a point in the process of bending. (2) The pin-hole image of a circular aperture crossed by a number of parallel needles shows "pin-cushion" distortion. The bright lines narrow down near the ends where they meet the circumference and tend to become normal to the circumference. (3) A spherical edge introduced between a pin-hole source and a lens causes unsymmetrical broadening of the image normal to the edges and also a considerable deviation towards the shadow of the diffracted image. AUTHOR.

**1341.** *The Brown Corona and the Diameters of Particles.* **L. F. Richardson.** (Roy. Meteorolog. Soc., J. 51. pp. 1–6, Disc., 21–24, Jan., 1925.)—Reference is made to Ray's theory of coronæ produced by water-drops of a particular size [see Abstract 1823 (1923)]. This applies for monochromatic light, but an ordinary lunar corona appears as an orange-brown ring and occasionally outside this a succession of other colours. Through a colour filter the corona appears indistinct. Pernter and Exner advised measurements on the red ring surrounding the chestnut-coloured ring, but this is not always visible, and thus the author always measured on the latter. Four different forms of apparatus were employed, and for diffracting objects use was made of Hoffman steel balls of $\frac{1}{32}$ in. diameter, an opaque photographic negative with numerous clear discs, holes in thin brass, and lycopodium powder. From the measurements the following variety of Airy's formula is given :—

$$\text{Diameter of obstacle} = \frac{5{\cdot}3 \times 10^{-5}\,\text{cm.}}{\sin\{(\text{radius of chestnut-brown corona}) - \frac{1}{2}\,(\text{radius of source})\}}.$$

This is not likely to apply to the smallest cloud-droplets of 2 microns diameter, but is more likely to apply to drops of ordinary size of, say, 5 to 20 microns diameter. R. S. R.

**1342.** *Magnetic Rotary Dispersion in Paramagnetic Solutions.* **R. W. Roberts.** (Phil. Mag. 49. pp. 397–422, Feb., 1925.)—Aqueous solutions of certain Co and Ni salts show anomalous rotary dispersion at their principal absorption-bands ; this anomalous rotary dispersion is much stronger for the Co solutions than for the Ni solutions. The high-frequency electrons in Co solutions, as well as in $K_3Fe(CN)_6$, give rise to the negative rotation displayed by these salts. The rotary dispersion in the solutions investigated may be calculated from the formula

$$\frac{\delta\lambda^2}{n(n^2+2)} = x\,\frac{\delta_w\lambda^2}{p_w(n_w^2+2)} + \Sigma\,\frac{a_s}{1-\lambda^{-2}\lambda_s^2}$$

which is derived from Drude's molecular current hypothesis by taking into account the electric polarisation of the liquids. A. D.

**1343.** *Stereoscopic Telemeter.* (Rev. d'Optique, 4. pp. 28–39, Jan., 1925.)—Describes with seven diagrams and photographic reproductions a special form of telemeter, due to Société d'Optique et de Mécanique de Haute Précision, with a 3-metre base. The apparatus can also function as an altimeter and a tachymeter. E. H. B.

**1344.** *A New Non-Intermittent Sensitometer.* **A. C. Hardy.** (Optical Soc. of America, J. and Rev. Sci. Inst. 10. pp. 149–156, Feb., 1925.)—A new non-intermittent sensitometer has been constructed which consists of two sector wheels rotating about the same axis at different angular speeds. During the exposure the larger disc makes only one revolution. In this interval the small disc makes many revolutions, but the large wheel covers the photographic material except for one revolution of the small wheel. With the ordinary sector wheel sensitometer the exposure range is rarely more than 256 to 1, because of the difficulty of cutting the wheel. It is shown that by using two sector wheels the exposure range may easily be increased to 16,384 to 1. An extension of this principle to three discs would not involve any serious mechanical difficulties and would increase the exposure range to more than 1,000,000 to 1.

AUTHOR.

**1345.** *Precision Densitometers for Photographic Photometry.* **G. R. Harrison.** (Optical Soc. of America, J. and Rev. Sci. Inst. 10. pp. 157–167, Feb., 1925.)—After discussion of the advantages of physical densitometers and microphotometers over the older types using the eye method, the merits and disadvantages of the more important recent designs are summarised. The conclusion is reached that the thermoelectric densitometer is most accurate for direct-reading work, while the photoelectric cell is best adapted for the null method. The disadvantages of the thalofide cell and the selenium cell seem to outweigh their only advantage of large currents. A simplified standard type of direct-reading densitometer is described, with vertical optical system, in which accuracy equal to the best claimed for the photoelectric null method, 1/10 of 1 %, was attained. The sensitivity was such that 1000 mm. deflections on an easily read scale were obtained through a clear plate with a slit 0·05 mm. wide, using only 20 watts in a lamp rated at over 70 watts. A single easily constructed thermocouple was used with a low-resistance d'Arsonval galvanometer. Curves are given showing the gradual improvement of deflection steadiness, from variations of 2 % to almost complete steadiness, as various sources of disturbance were eliminated. AUTHOR.

**1346.** *Precision Refractometer for Liquids.* **A. Lafay.** (Rev. d'Optique, 4. pp. 24–27, Jan., 1925.)—With this apparatus the determination of the index of refraction of a liquid results from a measure of the limiting angle of entry into the liquid of a ray which falls on it at grazing incidence. This ray is received by a special prism and the angle found on a method explained by aid of diagrams. The apparatus is like a compound microscope with special cells on the table. E. H. B.

**1347.** *Institute of Optics: Theoretical and Applied.* **A. de G. de Guiche.** (Rev. d'Optique, 4. pp. 1–7, Jan., 1925.)—Describes with three plans of the different floors the Institute of Optics now established in Paris. E. H. B.

**1348.** *On the Aberration of Light.* **L. Page.** (Astrophys. J. 61. pp. 70–72, Jan., 1925.)

**1349.** *Huyghens' Principle.* **W. Anderson.** (Phil. Mag. 49. pp. 422–426, Feb., 1925.)—Mathematical deduction, without analytical complexities, of Kirchhoff's general formula for the particular case where the primary light wave is completely given by $s = \frac{1}{r} \cdot f\left(t - \frac{r}{v}\right)$. A. D.

**1350.** *Velocity of Light.* **H. Thirring.** (Zeits. f. Physik, 31. 1–4. pp. 133–138, 1925.)—The ballistic theory [see Abstract 1410 (1924)] leads to results at variance with observation. The double-star data compiled by the Lick Observatory [see Abstract 1028 (1925)] tell conclusively against it. In any event the increase in the velocity of propagation of light from a moving source is less than one-millionth the velocity of the moving source. A. D.

**1351.** *Lecture Demonstration of the Velocity of Light.* **R. Pohl.** (Zeits. f. Physik, 31. 12. pp. 920–921, 1925.)

**1352.** *Spectrophotometry*. (Optical Soc. of America, J. and Rev. Sci. Inst. 10. pp. 169–241, Feb., 1925.)—This, the 1922–23 report of the Progress Committee on Spectrophotometry of the Optical Soc. of America, contains a complete *résumé* and bibliography (130 entries) of the whole subject. The terms used in the subject are first defined, and a nomenclature for transmission terms is suggested. The specification of colour is described and the different "whites" used are enumerated. The third section of the report deals with spectrometers and spectrometry, including calibration, dispersion, and stray light elimination. The fourth section describes the different methods adopted in photometry for varying the brightness of one part of the field. It also deals with the precision and accuracy attainable and the conditions affecting these. The fifth section describes the principal visual spectrometers now in use, and indicates the particular advantages to be had in the use of each type. In the sixth section the photographic, photoelectric and radiometric methods are described. In the seventh section the methods of conversion from spectrophotometric to colorimetric data are described and tables are given for (1) the relative elementary colour excitations at each wave-length, (2) the visibility function as now adopted internationally, and (3) the relative energy distribution throughout the visible spectrum of noon sunlight at Washington and of a black body at 5000° K. J. W. T. W.

**1353.** *Photoelectric Photometry*. **R. Jouaust** and **P. Waguet.** (Comptes Rendus, 180. pp. 59–61, Jan. 5, 1925.)—Describes the results of measurements made with photoelectric cells on the relative candle-powers of sets of standard lamps operating at certain definite efficiencies. The variations obtained in the measurements did not exceed 1 %, while the photoelectric values agreed with the visual values to the same degree of accuracy. J. W. T. W.

**1354.** *Conditions Governing the Behaviour of the Silver Bromide Grain during Development*. **L. F. Davidson.** (Phot. J. 65. pp. 19–28; Disc., 29–31, Jan., 1925.)—The object of the work was the determination of the change which AgBr undergoes on development. Single-layer plates were used. Development does not start in all grains simultaneously; there appears to be a separate induction period for each class of grain; but it starts, as previously noticed, at centres on the surface. These centres enlarge, join together, and the whole grain becomes blackened. In some emulsions there is a definite tendency for grains to develop in pairs or large clumps. To find whether there was some definite relationship between the increase in size of the grains and the speed and character of the plate actual measurements of grains were made before and after development. With a slow emulsion the increase in grain size is only about 0·9 %. In medium rapidity type the change of shape is more marked and an average increase of 16 %. With the fastest emulsion now obtainable there was a very marked increase, in some cases by 100 %. It is found that the increase in average grain size on development is directly proportional to the H. and D. speed. E. G.

¶**1355.** *Determination of Intensities on Photographic Plates*. **G. Hansen.** (Zeits. f. Physik, 29. 6. pp. 356–359, 1924.)—A device is described for printing on to a photographic plate strips having an intensity of blackening of calculable relative intensity. The relative intensities are claimed to be independent of the colour of the light and independent of its constancy, since all the strips are blackened at one and the same exposure. Light passes through a screen having a special aperture; then through a cylindrical lens, with its axis vertical; and finally through a double-convex lens on to the photographic plate. The screen and this lens are arranged to be in conjugate positions with respect to the plano-convex lens in between. Thus the plate is illuminated with light whose intensity depends upon the length of the aperture through which it has passed, so that such a screen as shown would give rise to four strips of differing intensity upon the plate. A photograph is given as a specimen taken with a ten-step aperture. A. C. M.

**1356.** *Some Applications of Photography in Modern Engineering, with Special Reference to Photomicrography.* **A. Logan.** (Phot. J. 65. pp. 9–16; Disc., 17–18, Jan., 1925.)—The paper is a popular sketch of the engineering applications of photography. Some hints are given on equipment for photomicrography and macrography. E. G.

**1357.** *Standard Development.* **W. Clark.** (Brit. Phot. Research Assoc. Lab. Comm. No. 41. Phot. J. 65. pp. 76–89, Feb., 1925.)—The object of this address is to provide a starting-point for a thorough discussion of the most suitable method of development of the exposed plate strip, and, with this object in view, the following concrete proposals are made: (1) The strips employed should be cut out of the middle of a large plate, to eliminate the edge effect, and should be backed for exposure. (2) Plate strips should be soaked in distilled water for a definite time and at a standard temperature immediately before development, say 5 mins. at 18° C. (3) Development should be by the dish method, using a deep dish and a good bulk of developer, *i.e.* 100 to 150 c.c. for a deep quarter-plate dish. (4) If made of metal, the developing dish should preferably be of silver or silver plate; glass, however, is the most suitable material to use. (5) The temperature of the developing apparatus must be maintained at an agreed standard, which is represented by a fairly average value of the annual room-temperature in temperate countries, say 18° C. (6) During development the rule stated before must be observed, *i.e.* the plate must be so treated that the products of development are swept from the plate surface and distributed throughout the developer as soon as they diffuse out of the film. This is best accomplished by actually sweeping the surface of the plate, and the use of a soft brush has proved practically to be best for this purpose; mere rocking and eddying is insufficient. (7) Use a pyro-soda developer containing no bromide. A formula similar to the standard adopted by Hurter and Driffield should be satisfactory, with the exception that less pyro is preferable. (8) Fixation should be in an acid thiosulphate bath of about 40 % concentration of thiosulphate. (9) The plate is preferably washed under a spray. (10) Before drying, the gelatine surface should be swabbed over with a piece of cotton-wool, and drying should be in still air at constant standard humidity and temperature, the plates being horizontal and emulsion side uppermost. [See Abstract 1157 (1924).]
E. G.

**1358.** *The Correspondence Principle and the Polarisation of Fluorescence Light.* **W. Heisenberg.** (Zeits. f. Physik, 31. 7–8. pp. 617–626, 1925.)—

Shows how an array of phenomena of intensity and polarisation of fluorescence light may be explained and quantitatively predicted by application of the principle of correspondence. A. D.

**1359.** *Theory of Polarised Fluorescence* (*Influence of Viscosity*). **F. Perrin.** (Comptes Rendus, 180. pp. 581–583, Feb. 23, 1925.)—Light emitted by a fluorescent solution is in general polarised [see Abstract 650 (1921)], and the amount, which is small for aqueous solutions, becomes important in more viscous solvents. The author explains this phenomenon by assuming the molecules of the fluorescent body to behave as electric oscillators, which, according to their orientations, absorb more or less of the exciting light. These excited molecules must have orientations distributed around a certain direction. In a very viscous medium the oscillators re-emit polarised spherical waves without change of orientation, and the fluorescent light will therefore be partially polarised. With diminishing viscosity the molecules will turn proportionately between the instants of absorption and emission, and the rate of polarisation will diminish. The paper, which is entirely mathematical, establishes for the case of a circular oscillator that the rate of polarisation is a homographic function of the viscosity, increasing from 0 to $\frac{1}{2}$ as the viscosity increases from zero to affinity. The theory is in excellent accord with recent measurements by Lewschin [Abstract 2734 (1924)] on erythrosine and rose bengal dissolved in various alcohols. H. H. Ho.

**1360.** *Intensities of Multiplet Lines.* **L. S. Ornstein** and **H. C. Burger.** (Zeits. f. Physik, 31. 5–6. pp. 355–361, 1925.)—The authors show that the conclusions of the Sommerfeld-Heisenberg theory of multiplets are in agreement with experimental measurements, and general formulæ are now given which permit intensities to be predicted where the Burger-Dorgelo summation rules are insufficient. [See Abstract 1455 (1924).] H. H. Ho.

**1361.** *The Intensity of Spectral Lines.* **A. Sommerfeld.** (Zeits. techn. Physik, 6. 1. pp. 2–11, 1925.)—Measurements of the relative intensity of lines of doublets and other multiplets are of equal importance from the aspects of the quantum and intra-atomic theories to precision measurements of the wave-lengths of line spectra. Such intensities are related in terms of whole numbers, and a theory is developed to explain upon the quantum-atomic theory the occurrence of multiplets. The theory is intricate and incapable of brief abstraction. B. J. L.

**1362.** *Stimulation of Atoms and Molecules to Light-Emission under Radiation.* **A. Terenin.** (Zeits. f. Physik, 31. 1–4. pp. 26–49, 1925.)—Optical stimulation of atoms considered and applied to Cd, Tl, Pb, Bi. The full spectrum of the emitted light consists of the following lines: Cd, 3261 ($1S \longleftrightarrow 2p_2$), 2289 ($1S \longleftrightarrow 2P$); Tl, 3776 ($2p_2 \longleftrightarrow 2s$), 5351 ($2p_1 \longleftarrow 2s$), 2768 ($2p_2 \longleftrightarrow 3d_2$), 3530 ($2p_1 \longleftarrow 3d_2$); Pb, 2833 ($2p_2 \longleftrightarrow 2s$), 3640 ($2p_3 \longleftarrow 2s$), 4058 ($2p_2 \longleftarrow 2s$); Bi, 3068 ($a \longleftrightarrow c$), 4723 ($b \longleftarrow c$), 2277 ($a \longleftrightarrow d$). On excitement of freshly formed Hg or Cd vapour by frequencies which fall within the respective absorption bands 1850 or 2289 there is a powerful re-emission of the incident wave-length, and in the case of Cd there is also an emission of 3261. These phenomena are to be attributed to molecules. A photographic method of measurement of the resultant emission-intensities in the ultra-violet. A. D.

**1363.** *"Dashed" and Displaced Terms in Spectra.* **O. Laporte** and **G. Wentzel** (Zeits. f. Physik, 31. 1–4. pp. 335–338, and **A. Landé** p. 339, 1925.)—The results of Landé, given in Abstract 110 (1925), are discussed and criticised in detail, and this criticism is followed by a reply by Landé. B. J. L.

**1364.** *The Periodic Structural Regularities of Spectra as related to the Periodic Law of the Chemical Elements.* **W. F. Meggers.** (Nat. Acad. Sci., Proc. 11. pp. 43–47, Jan., 1925.)—Gives a number of diagrams showing that the doublet of ionised calcium, 3933·66 Å. and 3968·47 Å. is due to the fall from the $P_2$ and $P_1$ levels to the $S_1$ level, in the same way as in the 7664·94–7699·01 doublet of neutral potassium, the next lower element in the table; that a triplet of ionised scandium, atomic number 21, results from the fall of electrons from the $F_2$, $F_3$ and $F_4$ levels to the $D_1$, $D_2$ and $D_3$ levels, just as in a triplet of neutral calcium, atomic number 20; also the relations for the quartets of ionised titanium (22) and neutral scandium (21), the quintets of ionised vanadium (23), and neutral titanium (22), and the sextets of ionised chromium (24), and neutral vanadium (23). In the last case lines are observed due to fall from levels $F_1$, $F_2$, $F_3$, $F_4$, $F_5$ and $F_6$ to levels $D_1$, $D_2$, $D_3$, $D_4$ and $D_5$. A table shows the systems of spectral structures for ten elements of the fourth period, for neutral atoms and for ionised atoms, giving numbers representing the maximum multiplicities in the spectral terms, or atomic energy levels, belonging to the corresponding systems of spectral structures, singlets, doublets, triplets, etc. These are alternately even and odd for successive elements; K 2; Ca 1, 3; Sc 2, 4; Ti 1, 3, 5; V 2, 4, 6, and so on for the arc spectra of neutral atoms; while for the spark-spectra of ionised atoms the numbers are: Ca 2; Sc 1, 3; Ti 2, 4; V 1 (?), 3, 5; Cr 2(?), 4, 6, and so on. A second table deals with the fifth period, which, however, is only very partially worked out. H. N. A.

**1365.** *Quantum Theory and Displacement of Spectral Lines.* **J. Kudar.** (Phys. Zeits. 26. pp. 207–211, Feb. 15, 1925.)—The relativistic theory gives a displacement $\nu = \nu_0\sqrt{g_{00}}$ for all light sources radiating in a gravitation field, provided we have "atom-clocks," implying that oscillation frequencies of atoms, measured in their proper times, are equal to one another at places of different gravitation potential. For hydrogen-like series and Deslandres-Schwarzschild band-spectra the author reaches the same result without any such proviso. A. D.

**1366.** *Spectra excited by Light and by Chemical Reactions.* **H. Kautsky** and **O. Neitzke.** (Zeits. f. Physik, 31. 1–4. pp. 60–71, 1925.)—The fluorescence and chemical luminescence of silicon was examined by photography and photometrically. Silicon was prepared by the decomposition of calcium silicide by water and subsequent purification of the finely divided silicon by hydrochloric acid. The paste of silicon and hydrochloric acid was contained in a test tube, which was placed before the slit of the spectroscope. Fluorescence was induced by exposure to ultra-violet light, and luminescence by treatment with potassium permanganate and stirring of the paste by compressed air. The results showed that the spectra of the chemical luminescence and fluorescence of fresh and old silicon were the same. The effects of fluorescence of the two dyestuffs, rhodamine B and genuine acid eosin, on the fluorescence of silicon was determined and the spectra of the activated silicon, under the oxidising action of potassium permanganate, and the two dyes were photographed and photometered. The comparative photometric curves of the fluorescence and chemical luminescence of the dyes are the same. The absorption spectra of rhodamine A and acid eosin by the transmission of the luminescence from silicon through the solution of dyestuffs are absolutely different from the luminescence spectra of the dyestuffs themselves. F. J. B.

**1367.** *The Isotope Effect in Band-Spectra. Part I.* **R. S. Mulliken.** (Phys. Rev. 25. pp. 119–138, Feb., 1925.)—The previous discussions by Loomis and Kratzer are generalised. The frequency $\nu$ of a line in the band-spectrum of a diatomic molecule may be considered as the sum of an electronic, a positive or negative vibrational and a positive or negative rotational contribution, $\nu = \nu^e + \nu^n + \nu^m$, where $n$ = vibrational and $m$ = rotational quantum number; $\nu^e$ should be substantially identical for corresponding band systems of two or more isotopes. The origin of a band system is defined by $\nu = \nu^e$, $\nu^n = \nu^m = 0$. If $\nu_1^n$ and $\nu_2^n$ are the vibrational contributions due to two isotopes, the nuclear masses of which are $M_1$ and $M_2$, it is shown that approximately $(\nu_2^n - \nu_1^n) = (\rho - 1)\nu_1^n$ where $\rho = \sqrt{(1/M_2 + 1/M')/(1/M_1 + 1/M')}$, $M'$ being the mass of the other nucleus composing the molecule. Diagrams are given showing typical band patterns for a mixture of two isotopes based on the above expression; these show that the greater the distance from the origin of the band system the greater is the separation between the bands due to the two isotopes. The rotational isotope effect is also considered, and may either increase or decrease the magnitude of the total isotope effect. Both these effects increase with $M'$ and diminish with M the atomic weight of the isotopic element. The effect is so large that it furnishes a new method of determining the isotopes of a given element, and promises to be of considerable value in confirming and supplementing the results of positive ray determinations. The existence of $Si^{30}$, previously in doubt, has been confirmed, and the relative intensities of $Si^{29}$ and $Si^{30}$ found from the SiN band-spectrum have been verified by Aston with the mass spectrograph. The results obtained constitute very strong new evidence for the correctness of the main features of the theory. The isotope effect may reveal at a glance whether a given band-spectrum in which an element M is concerned is due to MH, MO or $M_2$; in the case of boron it seems almost possible to decide between BO and BN as the source of the band-spectrum.

H. N. A.

**1368.** *The Application of the Correspondence Principle to Degenerate Systems and the Relative Intensities of Band Lines.* **E. C. Kemble.** (Phys. Rev. 25. pp. 1–22, Jan., 1925.)—This paper originated in an attempt to harmonise the Kratzer half-integral quantum numbers, for which there is strong evidence, with the observed symmetry in the intensities of the two branches of the HCl band at $3 \cdot 46\ \mu$. First the infra-red spectrum of non-gyroscopic diatomic molecules is calculated, treating the molecule as a degenerate system with but one quantum condition for two degrees of freedom, following the detailed rules proposed by Kramers. This leads to a formula for the relative intensities of the lines in the two branches of the band, which is unsymmetrical and disagrees with the experimental observations. A comparison between the theory and experiment involves the computation of the total absorptions to be expected in a tube of appreciable length using a relatively wide slit. If this computation is based on the assumption that the lines have no unresolved fine structure, the estimated absorptions do not agree with experiment; but the assumption that such a fine structure does exist, combined with the integral absorption coefficients of the modified theory, gives fair agreement with the available observations. General theory of transition probabilities.—It is pointed out that the usual method of calculating probabilities involves a discontinuity in the intensities of spectrum lines when a degenerate system is converted into a non-degenerate one, as by a weak magnetic field. This seems improbable, and the failure of the first calculation indicates that the usual rules for the treatment of degenerate systems require modification. AUTHOR.

**1369.** *Band-Spectra.* **R. Mecke.** (Phys. Zeits. 26. pp. 217–237, Feb. 15, 1925.)—This paper gives a *résumé* of recent work on band-spectra, and treats of their structure, arrangement in series, Zeeman-effect, effect of isotopes and experimental data. In particular the second spectrum of hydrogen and the band-spectrum of helium are considered, and then those shown by each group in the periodic table. An exhaustive bibliography is included. F. S.

**1370.** *Heat of Rotation of Hydrogen.* **E. Schrödinger.** (Zeits. f. Physik, 30. 6. pp. 341–349, 1924.)—The paper is a new development of the spectral-band theory, from the electron impulse, which is probably 1/2 at right angles to the lines forming the nucleus. The theory of the heat of rotation is influenced by the reduction of the moment of inertia of the molecules to 2/3 of its usual value. For details the original paper must be consulted. F. J. B.

**1371.** *Spectrum of Nitrogen.* **T. R. Merton** and **J. G. Pilley.** (Roy. Soc., Proc. 107. pp. 411–422, March 2, 1925.)—It has been shown by Merton and his collaborators that the spectrum of a substance is greatly modified when a discharge is passed through a tube containing helium at comparatively high pressure and a very small quantity of the substance. A trace of carbon gives a spectrum assigned to the neutral atom, and with nitrogen the NI line spectrum replaced the band spectrum as the quantity was reduced, while it was in turn replaced by the line and band spectrum of helium. Tubes of the H pattern were used with a tube of 8 to 12 mm. bore replacing the usual capillary. A number of side tubes were attached containing phosphorus pentoxide, caustic potash, potassium permanganate and alumina moistened with sodium oxide solution. These materials permitted the removal of impurities and the introduction of nitrogen. The spectra were photographed with a grating spectrograph having a concave grating with 20,000 lines per inch and of 4 ft. radius of curvature, giving a dispersion of 10 Å. per mm., and also

with a large Littrow spectrograph with glass prism, giving 40 Å. per mm. at $\lambda = 7500$ Å. and about 5 Å. per mm. at $\lambda = 3700$ Å. A table of wave-lengths, intensities and wave-numbers is given in which Hardtke's values are given for comparison. An attempt to replace helium with argon was unsuccessful, only the strongest lines being visible with intense discharge. Excitation by electron impacts showed that as the energy of impact is increased there is transition from the negative band spectrum to the spark spectrum, which would imply that the rupture of nitrogen molecules is generally into ions rather than neutral atoms. It is suggested that the action of helium in promoting the NI spectrum is due to the presence of a high proportion of nitrogen atoms while the helium carries a heavy discharge, and also that the helium protects the nitrogen from greater potentials than 20·4 volts, *viz.* the first resonance potential of helium, and thus arc lines are excited in preference to spark lines.
F. S.

**1372.** *Over- and Combination-Oscillations of the $NH_3$ Molecule.* **G. Hettner.** (Zeits. f. Physik, **31.** 1–4. pp. 273–276, 1925.)—It is known that the nuclear oscillations of molecules, as shown by bands in the short wave ultra-red, are attended mainly by over-oscillations, whose frequencies possess values $p\nu_0$ ($p = 1, 2, 3 \ldots$), if $\nu_0$ be the frequency of the fundamental oscillation. Recently the author [see Abstract 1073 (1920)] has shown from the nuclear oscillations of the $H_2O$ molecule that this phenomenon is general, and that when several fundamental oscillations are present combination oscillations occur. From the quantum standpoint this signifies that not only does the quantum number of an oscillation spring from several units, but also that the quantum numbers of different oscillations can simultaneously change. Schierkolk's work on the ultra-red absorption spectrum of ammonia [see Abstract 354 (1925)] is quoted in support. It is now shown that the nuclear oscillations of the $NH_3$ molecule may be established as over- and combination-oscillations of two fundamental frequencies, and that here, as with other gases, only summation and not difference effects are observed.
H. H. Ho.

**1373.** *Infra-red and Electric-wave Spectra.* **E. F. Nichols** and **J. D. Tear.** (Astrophys. J. 61. pp. 17–37, Jan., 1925.)—The short electric-wave spectrum has been extended to 0·22 mm., the source being a modified Hertzian oscillator consisting of a doublet of small tungsten cylinders sealed into the ends of glass tubes. The receiver was an adaptation of Nichol's radiometer with elements of fine platinum wires or platinum films on mica. Wave-length measurements were made with an interferometer of the Fabry and Perot type, with Boltzmann mirrors and with a reflecting echelon. The fundamental wave-lengths of the oscillators were found to be about 4·5 times the length of the doublet. The smallest oscillator had a fundamental of 0·9 mm. Under certain conditions the fundamental is suppressed and an overtone accentuated. Such have been observed with wave-lengths as short as 0·22 mm. The radiation from the quartz mercury arc, when filtered through 2 mm. of fused quartz and two sheets of black photographic wrapping-paper, resembles that obtained by focal isolation. The shorter components are reduced in intensity by 8 mm. of fused quartz and four sheets of paper, so that a wave-length near 0·42 mm. predominates. The mercury arc interference curves indicate wave-lengths near 228, 294, 412 and possibly 685 $\mu$, as

predicted by the quantum theory, assuming the moment of inertia of the source to be $5 \cdot 7 \times 10^{-40}$. This is in accord with evidence attributing the band-spectrum of mercury to the presence of a mercury hydride.
F. S.

**1374.** *Spectrum of Mercury under Heavy Current Excitation.* **M. Fukuda.** (Japanese Journ. Phys. 3. 4–6. pp. 139–153, 1924. In English.) —The spectrum of mercury was examined by Hansen, Takamine and Werner, who found a number of lines forbidden by the principle of selection. Similar observations were made by Takamine and the author for constricted arcs, and have now been made by the author while using a special mercury arc devised by Metcalfe. This lamp has a long horizontal tube with quartz windows joined on to the small lamp. A discharge can be passed between two electrodes sealed into the tube when the lamp has been started some time. The spectra were photographed with various types of Hilger quartz spectrograph. Higher members of diffuse series $2p_2 - md_2$, $2p_3 - md_3$ and $2P - md_2$ were observed, and their wave-lengths are given in tables, the mode of broadening being described. Lines whose occurrence is prohibited by the principle of selection are also listed with series notation. From the mode of occurrence of these lines, the intensity of electric field along the path of discharge is expressed as a function of current density, and the minimum fields to produce them determined.
F. S.

**1375.** *Arc Spectra of the Platinum Metals* (4500 Å. *to* 9000 Å.). **W. F. Meggers.** (Bureau of Standards, Sci. Papers, No. 499. pp. 19–45, 1925.) —Previous workers have been obliged to use metal sponge or salts on carbon or copper electrodes. An investigation of these metals at the Bureau enabled the use of ingots of Pt and Pd and sponge of the other metals, which was used on electrodes of copper or silver. Two gratings of 640 cm. radius were used, one with 7500 lines per inch, giving 10·4 Å. per mm., and the other with 20,000 lines per inch, giving 3·75 Å. per mm. The former had a brighter spectrum, which is of importance for infra-red photography. The plates were bathed with pinaverdol, pinacyanol or dicyanin, according to the range of spectrum. New values of wave-lengths and estimated relative intensities are given in six tables as follows: 1260 lines for ruthenium (4498·16 to 8867·84 Å.), 572 lines for rhodium (4503·80 to 8615·23 Å.), 172 lines for palladium (4497·66 to 9234·02 Å.), 942 lines for osmium (4500·74 to 8644·8 Å.), 605 lines for iridium (4500·97 to 8426·11 Å.), and 239 lines for platinum (4498·75 to 8762·48 Å.). The wave-lengths were measured relative to the secondary standards in the spectrum of the iron arc, and each value is, in general, the mean of from 2 to 10 determinations. The probable error of these values rarely exceeds 0·01 Å. Six short tables, giving lines ascribed to platinum metals by other observers, but not visible on the new spectrograms, are subjoined to the major tables, and most of these lines are identified as impurities in the materials at the disposal of the earlier observers. Intercomparison of the results of the new measurements indicates that the metals used in this investigation were exceptionally pure, since even the most intense lines characteristic of each element rarely, if ever, appeared in the spectra of the other elements.
F. S.

**1376.** *Ultra-violet Spark Spectra of Certain Elements.* **R. J. Lang.** (Roy. Soc., Phil. Trans. 224. pp. 371–419, Dec. 12, 1924.)—A modified

form of the vacuum spectrograph used by McLennan was employed to investigate the spectra of C, Ca, Li, V, Cr, Mn, Co, As, Mo, Cd, Sn, Sb, Te, Ce, Pt, Au, Tl, Pb, Bi, and U. The source was brought nearer to the slit, and windows were introduced at different points to facilitate alignment. Two sets of pumps were used, one set to produce the rough vacuum, being high-capacity pumps, and then a backed diffusion pump to raise and maintain the vacuum. The exposure time was cut down to half an hour of intermittent sparking, equivalent to about three minutes continuous sparking. Wave-lengths are given from 2000 Å.U. down to as low as 224 Å.U. The wave-numbers are given for most of the lines recorded, and also, for comparison, the results of other observers.
**A. C. M.**

**1377.** *Excitation of Spark-Spectra.* **S. Werner.** (Nature, 115. pp. 191–192, Feb. 7, 1925.)—For the excitation of such spark-spectra as that of lithium a new apparatus has been designed in which the vapour is allowed to escape into a high vacuum and exposed to electron bombardment. For lithium a temperature of the crucible of 1000° C. is necessary. The pressure could be reduced below 0·001 mm. and the electrons impinged upon the escaping vapour near the orifice of the crucible. The electron current could reach 500 m.a., and accelerating voltages up to 1400 volts have been applied. The value for lithium is about 300 volts. A table of wave-lengths and suggested term notations is given, the values agreeing in general with Schüler's results. In addition to the spark spectrum the arc spectrum was also strongly excited, the sharp and diffuse series being observed up to the 10th and 14th members respectively. With high vapour-pressure and anode potential exceeding 500 volts, an arc struck between crucible and anode which showed spark lines in addition to the arc lines.
**F. S.**

**1378.** *The Absorption Spectra of Copper, Silver and Gold Vapours in the Ultra-violet.* **R. V. Zumstein.** (Phys. Rev. 25. pp. 523–526, April, 1925.)—Using a carbon tube heated to between 1600° C. and 2000° C. with an oxy-acetylene torch, the absorption spectrum has been studied in the ultra-violet to 2000 Å. With copper, besides strong absorption at the first pair of the principal series 3273·9 and 3247, in agreement with Grotrian, lines were found at 2225, 2182, 2178·9, 2165, 2024·3 and, with 2000° C., at 2244. The second pair of the principal series has been calculated by Randall to come at 2024·4 and 2025·7, but the absence of any trace of the second line makes this identification still uncertain. With silver very strong absorption was obtained at 3382 and 3280 (as by Grotrian) and also at 2070 and 2061·2. These are the first two pairs of the principal series. With gold there was distinct absorption only at 2675·9 and 2427·9, indicating that these lines are the first pair of the principal series.
**Author.**

**1379.** *Measurements of the Intensity of the Lines of the Many-lined Spectrum of Hydrogen at Different Temperatures and Pressures.* **F. Goos.** (Zeits. f. Physik, 31. 1–4. pp. 229–239, 1925.)—A photographic photometric arrangement is fully described, by means of which the relative intensities of the Fulcher triplets and some other lines in the red part of the many-lined spectrum of hydrogen are investigated for three different temperatures and four different densities of the gas, also for twelve different conditions. The results are given in both tabular and graphical form. It is found that, relative to a standard line, a part of the lines are sensitive to temperature as well as pressure, while of the others some are sensitive to density only and the remainder to temperature only. A. E. G.

**1380.** *The Fine Structure of He* 5876 Å. **Rita Brunetti.** (Accad. Lincei, Atti, 33. ii, pp. 413–415, Nov. 16, 1924.)—Discusses the observations and arguments of Nutting, Lohmann, Ruark, Foote, Mohler, Ornstein and Burger. Concludes that Nutting's additional satellite is, experimentally, due to an inversion of the line $D_3$ and Lohmann's to the presence of a phantom, and that the origin of the fine structure of He 5876 Å. still remains unexplained. A. D.

**1381.** *Notes on Neodymium Oxide.* **E. L. Nichols.** (Nat. Acad. Sci., Proc. 11. pp. 47–52, Jan., 1925.)—Gives a curve, obtained with the spectrophotometer, with ten or more crests on the brightness curve of the visible spectrum of the glowing solid ; these are doubtless the envelopes of groups in a much more complicated structure. They fall into two sets, the frequency differences being multiples of 18·5 for both sets ; this is the Tanaka interval for neodymium, observed in the spectrum of kathode luminescent substances in which neodymium is the activating element. The brightness of the oxide at about 900° C. is greatly in excess of that of a black body ; there is luminescence superimposed on incandescence, as shown by the curve mentioned above. Above 1000° C. the banded spectrum disappears. Observations were made at temperatures so low that the incandescence of the comparison black body was too dim for easy measurement, but it was possible to estimate temperatures down to 600° C. by measuring the distance of the heating hydrogen flame from the glowing surface. A curve showing the ratio of the luminous intensity of the oxide to that of the black body from 600° to 1000°, with a maximum value of over 800, was obtained ; this applies to the group of bands at the red end of the spectrum. The fatigue of luminescence, the spectrum of a bead of microcosmic salt containing neodymium oxide, as distinguished from that of the glowing oxide in bulk, and the relation between these spectra and the absorption spectra of the element are dealt with. H. N. A.

**1382.** *New Regularities in the Spectra of the Alkaline Earths.* **H. N. Russell** and **F. A. Saunders.** (Astrophys. J. 61. pp. 38–69, Jan., 1925.) —Ninety-seven lines of Ca, 55 of Sr and 95 of Ba, not included in ordinary series, have been identified as combinations between known spectroscopic terms and new terms. Practically all the lines of Ca and Sr are now accounted for. Tables of wave-lengths, wave-numbers and of new terms are given. A series of five groups of six lines each has been found in Ca, including the strong groups near λ4300 and λ3000, and new groups near λ2560, λ2360 and λ2260. The first two members of similar series have been identified in Sr and Ba. Three more new series appear to exist in each spectrum, of which only the first one or two members appear. All these series belong to the triplet system. The new terms account for about half the strong lines in each spectrum. Their inner-quantum properties are normal ; the combinatory (azimuth-quantum) properties are sometimes normally related to the others, but sometimes correspond to a change of the usual azimuth-quantum number by ± 1. Such terms are called $p'$, $d'$; the former $p''$, $d''$. The numerical values of the terms are negative in several instances, and the limit of the $pp'$ series in Ca is different from that of the ordinary series. The negative terms show that a neutral atom can contain more than enough energy to ionise it. This is explained by both valency electrons being displaced to outer orbits, and both may jump at once from outer to inner orbits, while the net energy lost is radiated as a single quantum, the atom acting as a whole. The anomalous relation of the azimuthal and inner-quantum properties can be explained by assuming that the angular momenta of the two valency electrons are quantised in space with respect to each other, and their resultant quantised with respect to that of the residue of the atom. This accounts also for the fact that the triplet separations of the anomalous terms increase from $p''$ to $d'$ and $f''$. F. S.

**1383.** *Halogen Isotopes and Infra-red Reflection Spectra.* **A. H. Pfund.** (Nat. Acad. Sci., Proc. 11. pp. 53–55, Jan., 1925.)—A previous paper by the same author [Abstract 121 (1925)] on selective reflection from inorganic salts showed that all sulphates showed bands near 9·05 $\mu$ and nitrates showed a band near 7·40 $\mu$ in the infra-red. From a comparison of the data furnished by Aston on halogen isotopes and selective reflection in the region of long wave-lengths by Rubens, it develops that each halogen salt of potassium has as many bands of selective reflections as there are isotopes. Upon plotting wave-numbers $\left(\frac{1}{\lambda}\right)$ against atomic weights a series of straight lines result, the curve for the heavier isotopes being parellel to that for the lighter, and iodine lies on the lighter Br and Cl curve as being the configuration of greater stability. Further experiments are in progress. S. G. B.

**1384.** *Spectrum of Ammonia Gas at* 3 $\mu$. **B. J. Spence.** (Optical Soc. of America, J. and Rev. Sci. Inst. 10. pp. 127–132, Feb., 1925.)—A grating spectrometer with a grating of 2500 lines per inch and a radiometer were used. The absorption chamber was 15 cm. long, provided with quartz windows, and could be replaced by quartz plates of equal thickness to the windows. The first order at 3 $\mu$ was used and higher orders ignored, as their energy was negligible. The gas was used at atmospheric temperature and pressure. Values of wave-lengths of absorption lines are given, and it is shown that there is a double branched band at 3 $\mu$. The branches are not, however, equally spaced about the zero branch, as indicated by theory, but the frequency difference is greater for the longer-wave branch. The harmonic band at 1·5 $\mu$ was located, but the intensity was too feeble for accurate measurement. F. S.

**1385.** *Regularities in the Nitrogen Spark Spectrum.* **C. C. Kiess.** (Science, 60. p. 249, Sept. 12, 1924.)—Certain lines have appeared during experiments in the infra-red, whatever the nature of the electrodes used to form an arc. These have been attributed to the gases of the atmosphere. The nitrogen lines observed among these most frequently are ones resulting from the combination of a triple $p$-term with an $s$-term, or with another triple $p$-term or with a five-fold $d$-term. They belong, therefore, to a quintet system, and consequently will probably be due to ionised nitrogen. A table is given of the combining terms, wave-lengths, intensities, and wave-numbers of the lines. The separations of the terms are roughly in accord with Landé's interval rule. A. C. M.

**1386.** *Line Spectrum of Ionised Oxygen.* **F. Croze.** (Comptes Rendus, 180. pp. 432–433, Feb. 9, 1925.)—A number of double-terms have been observed in the multiplets of ionised oxygen. The wave-lengths are based upon those given by Kayser, and were obtained by applying Landé's rules to measurements of the Zeeman-effect produced by a field of 24,000 gauss upon spectra in the 3rd and 4th orders of a Rowland grating of 3·14 m. radius. F. S.

**1387.** *Continuous Hydrogen Radiation in Celestial Spectra.* **J. W. Nicholson.** (Roy. Astron. Soc., M.N. 85. pp. 253–256, Jan., 1925.)—Evershed observed a continuous spectrum belonging to the solar chromosphere and prominences which extended from near the head of the Balmer series towards the violet. Similar continuous spectra have been observed by other workers, and reasons are given why an investigation of the law of intensity distribution along the spectrum is needed for a further generalisation of the quantum theory of emission spectra. It is suggested that the work be done by astronomers, in view of the difficulty of producing the spectrum in the laboratory. F. S.

**1388.** *The Spontaneous Reversal of the Lines of the Neon Spectrum.* **H. Buisson** and **C. Jausseran.** (Comptes Rendus, 180. pp. 505–507, Feb. 16, 1925.)—Fabry and one of the authors have showed that the neon spectrum contains certain fine lines, which give interferences when the phase difference is very large, and are suitable for use in metrology [Abstract 1190 (1912)]. Pérard, however, found that several of these lines are not simple ones, being doublets which produce disappearance and subsequent reappearence of the fringes [Abstract 1138 (1923)]. The authors show that the effect is due to spontaneous reversal of these lines when emitted by a certain thickness of the luminous gas. If the tube has a capillary central portion, and the light coming out at right angles to the capillary is made use of, the interference fringes, with a difference of path of 30 mm., are perfectly fine and simple, except for the line 6402; if, however, the light emitted along the length of the tube is used, most of the lines give double fringes with the optical apparatus employed, the separation varying for different lines. It appears that the neon lines are not suitable for standards of wave-length. H. N. A.

**1389.** *The Structure of the Vanadium Spectrum.* **K. Bechert** and **L. A. Sommer.** (Zeits. f. Physik, 31. 1–4. pp. 145–162, 1925.)—The structure of the vanadium spectrum has been intensively studied recently by Meggers, Laporte, Catalan and others. The authors, by a study of fifteen multiplets, have improved the existing term system of vanadium. A doublet system is found in addition to the sextet and quartet systems. The original paper should be consulted for details. W. V. M.

**1390.** *Anomalous Intensities in the Negative Nitrogen Bands.* **G. H. Dieke.** (Zeits. f. Physik, 31. 1–4. pp. 326–334, 1925.)—Intensity anomalies of lines in the negative nitrogen band-spectrum, to which attention has been directed by Mecke and others [see Abstracts 2972 (1924) and 109 (1925)] may be eliminated from the discussion of these bands, without destroying any of the combination relations, by considering each series as made up of a strong and weak component series. Attention is directed to a resemblance between the structure of this spectrum and the structure of the helium band, λ5730 Å., and the fine structure of the lines is discussed. The band λ3914 Å. gives the respective values $3\cdot33 \times 10^{-40}$ and $3\cdot59 \times 10^{-40}$ for the moment of inertia of the nitrogen molecule in its initial and final condition respectively. J. S. G. T.

**1391.** *Relative Probabilities of the Transitions involved in the Balmer Series Lines of Hydrogen.* **F. C. Hoyt.** (Phil. Mag. 47. pp. 826–831, May, 1924.)—In a previous paper [Abstract 2201 (1923)] the author has briefly described the general theory, based on Bohr's correspondence principle, of the probability of transition in unit time from one stationary state of the atom to another, giving a basis for the estimation of the intensity of spectral lines. The probabilities may be estimated by a comparison of the rate of emission of energy by a classical harmonic oscillator of frequency $\nu$ and amplitude Q with the quantity, $h\nu A'_{11}$, which represents this rate of emission on the quantum theory, $A'_{11}$ being the probability of spontaneous transition in unit time, and a kind of mean value, $Q^2\nu^4$ of $C^2\omega^2$ being introduced in estimating $A'_{11}$, where $\omega$ and C are the frequency and amplitude of the corresponding harmonic component. Six different methods of evaluating the mean value were briefly discussed in the previous paper; these are made use of to calculate the relative values of $A'_{11}$ for various transitions, and the average value of the coefficient of absorption, $\sigma$, for each transition, on each assumption, is arrived at. The relative values of $\sigma$ could be found from measurements of the total absorption, but data do not exist for the H lines. Ladenburg has suggested that they may be obtainable from measurements on anomalous dispersion. The experimental data are hardly of sufficient accuracy to allow of a definite choice between the different methods of averaging. [See next Abstract.] H. N. A.

**1392.** *Note on the Problem of the Quantitative Formulation of Bohr's Correspondence Principle.* **R. C. Tolman.** (Phil. Mag. 49. pp. 130–136, Jan., 1925.)—Kramers has shown that, when an atom passes from one quantum state to another, the frequency of the light emitted may be regarded as an average of the frequencies which would be emitted, on the basis of the classical theory, by the various mechanically possible states between the two quantum states. Bohr's correspondence principle indicates a similar relationship for the intensity of the emitted light. In the present paper different methods of averaging are used, and the probability of transition is calculated for three very simple quantum systems with only a single degree of freedom: the harmonic oscillator, the rotating dipole and the simplified hydrogen atom with circular orbits. A table gives expressions for the square of the amplitude of the virtual oscillator, the probability that the transition from quantum state $n + 1$ to $n$ will take place in unit time, the square of the amplitude of the virtual oscillator for the transition from quantum state 1 to state 0, and the probability of this transition in unit time. One of the methods of averaging (F) leads to what appears to be experimentally correct—the value zero for the chance of the electron falling from the innermost orbit of the hydrogen atom into the nucleus—while the other methods give the value infinity. On the other hand, it has been assumed that the inverse square law of attraction holds down to zero distance between nucleus and electron, so that the above fact cannot be regarded as proving that F is the correct method. A footnote suggests a connection between the result with method F and the hypothesis that the energy supply of certain stars comes from the destruction of matter. [See preceding Abstract.] H. N. A.

**1393.** *The Theory of the Periodic System.* **A. Sommerfeld.** (Phys. Zeits. 26. pp. 70–74, Jan. 1, 1925.)—Stoner has propounded a scheme of orbit arrangement which forms a considerable step in advance [Abstract 38 (1925)]. The first line of the following table shows the Bohr-Coster nomenclature for the X-ray levels, the second that proposed by the author in the last edition of his "Atombau und Spectrallinien," with double indices, the first being Landé's $k$ and the second $j$; if S is one of the layers K, L, M . . ., the general symbol for an X-ray level or sub-group is $S_{kj}$; $\Delta k = \pm 1$, $\Delta j = \pm 1$ or $0$; the third line shows that the number, arrangement and numbering of the levels corresponds throughout to the doublet character of the alkalies; the subscript indices give the inner quantum number $j$; in the last line are the quantum weights of the respective terms, which are equal to $2j$; from these the intensities of the optical multiplet lines can be calculated by means of the rules of Burger and Dorgelo, and Stoner assumes that the quantum weights give the number of electrons in the completed X-ray sub-groups:

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| K | $L_I$ | $L_{II}$ | $L_{III}$ | $M_I$ | $M_{II}$ | $M_{III}$ | $M_{IV}$ | $M_V$ | $N_I$ | $N_{II}$ | $N_{III}$ | $N_{IV}$ | $N_V$ | $N_{VI}$ | $N_{VI}$ |
| K | $L_{11}$ | $L_{21}$ | $L_{22}$ | $M_{11}$ | $M_{21}$ | $M_{22}$ | $M_{32}$ | $M_{33}$ | $N_{11}$ | $N_{21}$ | $N_{22}$ | $N_{32}$ | $N_{33}$ | $N_{43}$ | $N_{44}$I |
| 1s | 2s | $2p_1$ | $2p_2$ | 3s | $3p_1$ | $3p_2$ | $3d_2$ | $3d_3$ | 4s | $4p_1$ | $4p_2$ | $4d_2$ | $4d_3$ | $4f_3$ | $4f_4$ |
| 2 | 2 | 2 | 4 | 2 | 2 | 4 | 4 | 6 | 2 | 2 | 4 | 4 | 6 | 6 | 8 |

According to Stoner, each sub-group is *fully* completed as the atomic numbers increase, thus differing from Bohr. When a sub-group is completed a symmetrical configuration of the orbits is reached, the impulse moments and magnetic moments of the orbits compensating one another. This is true not only for the inert gases, but for the alkaline earths and for Zn, Cd and Hg, and is confirmed by the diamagnetic behaviour of their vapours and by Stern's atomic stream experiments, in which no deviation was observed with these three elements. There is also spectroscopic evidence. Similar results are found after the completion of the sub-groups $L_{21}$, $M_{21}$, $N_{21}$ and others. H. N. A.

**1394.** *The Intensity of X-Ray Lines.* **A. Sommerfeld.** (Ann. d. Physik, 76. 2–3. pp. 284–291, Jan., 1925.)—According to the relativity doublet formula the quantum number which distinguishes between the two levels of a relativity doublet has the character of an azimuthal quantum number $k$ [Abstract 2200 (1923)]. On the other hand, Grotian and Landé deduce from the selective principle that this is an inner $j$ quantum number; Landé and Bowen and Millikan, by comparison of the X-ray and the visual doublets, confirm this, and the author gives additional arguments which point in the same direction, one of which depends on the relation between the intensity of the X-ray lines. In the visible region it has been found that for the simple doublet (*sp*) or (*ps*) the ratio of the D lines 2 : 1 holds, and also for the higher members of the principal series. The ratio for the compound doublet (*pd*), with the principal lines and a satellite is 9 : 1 : 5. The symbols used in this paper for the orbit levels are the same as in the preceding abstract. In the K-series the doublet K$\alpha$, $\alpha'$ corresponds to the doublet (*sp*) of the alkalies, the lines $D_2$, $D_1$, for example; *K*$\alpha$ corresponds to the transference $L_{22} \rightarrow K$ and K$\alpha'$ to $L_{21} \rightarrow K$. The ratio of the intensities has been found by Siegbahn and Zacek to be 100 : 50 for Fe, Cu, Zn; the same ratio had previously been found for $M_0$ and W. The three lines of the complex doublet L$\alpha$, $\alpha'$, $\beta$ result from the transferences $M_{33} \rightarrow L_{22}$, $M_{32} \rightarrow L_{22}$ and $M_{32} \rightarrow L_{21}$, and correspond to the (*pd*) doublet of the alkalies, L$\alpha$ and L$\beta$ being the first and second principal lines and L$\alpha'$ the satellite. The observed intensity ratios agree within the limits of observational accuracy with that given above for the visual spectrum 9 : 1 : 5. Stoner's theory of the periodic system is shown to lead to results, in the case of the rare earths, which agree qualitatively with the division into cerium earths and ytterbium earths and with their magnetic relations. In the iron group, however, the relation between the building up of the electronic levels and the magnetic behaviour is not the same as for the rare earths. H. N. A.

**1395.** *Intensity Measurements in Multiplets.* **R. Frerichs.** (Zeits. f. Physik, 31. 1–4. pp. 305–310, 1925.)—Upon the quantum theory of radiation, specific relations exist between the relative intensities of doublet and other multiplet lines, and from the aspect of this theory and the theory of atomic structure the determinations of intensity of particular lines are of great importance. The present paper deals with the experimental difficulties and errors when lines in the visible spectrum approach the ultra-violet region. A particular form of Rowland grating apparatus for the determination of relative intensity is described and results obtained for the *dd'* and DD' groups of lines for calcium and chromium given. These are found to agree closely with theoretical predictions.

B. J. L.

**1396.** *Significance of the Discovery of X-Ray Laws in the Field of Optics.* **R. A. Millikan** and **I. S. Bowen.** (Nat. Acad. Sci., Proc. 11. pp. 119–122, Feb., 1925.)—Series of atoms of elements from sodium to chlorine and lithium to nitrogen have been obtained without valence electrons [see Abstract 135 (1925)]. The working out of the corresponding energy levels has shown that the Moseley and irregular doublet laws hold in the case of optical spectra as well as in X-ray spectra. The same seems to hold also for the regular or relativity doublet law. As this would involve the abandonment of either relativity causes and effects or of Bohr's interpenetration ideas, the data have been again examined. It is concluded from small discrepancies in values of the screening constant that only the doublets of hydrogen and helium really obey the law, and that those for other elements are not really relativity doublets, although they very nearly obey the same law. F. S.

**1397.** *Reflection of Röntgen Rays.* **P. P. Ewald.** (Phys. Zeits. 26. pp. 29–32, Jan. 1, 1925.)—The chief part of the intensity of reflected Röntgen rays is due to total reflection; this displaces former views as to the effect of the structure-factor. The angular field within which total reflection takes place is in symmetrical reflection of monochromatic light proportional to S cot $\delta$, where $\delta$ is the angle of incidence and S is the amplitude of structure. The intensity is proportional to S cot $\delta$, not to $S^2$, as hitherto accepted. These results are in accord with W. L. Bragg's measurements on arragonite, W. H. Bragg's on diamond, and R. v. Nardroff's on pyrites. A. D.

**1398.** *The K Röntgen-Ray Absorption Spectra of Si, Ti, V, Cr, Mn and Fe.* **A. E. Lindh.** (Zeits. f. Physik, 31. 1–4. pp. 210–218, 1925.)—As in P, S, Cl, K, Ca (**Lindh**), so in the above elements the K Röntgen-ray absorption spectra depend on the state of chemical combination of the absorbing atoms. Coster's anomalous absorption lines in Ti, V, Cr and Mn higher oxygen compounds [Abstract 2521 (1924)] traced to the free element, liberated by reduction of the higher oxygen compounds during the Röntgen radiation. Tables of data. A. D.

**1399.** *Theory of the Width of the Modified Spectrum Lines in the Compton-Effect.* **G. E. M. Jauncey.** (Phil. Mag. 49. pp. 427–433, Feb., 1925.)—The scattering of X-rays is accompanied by the phenomenon that part is scattered with, and part without, change of wave-length. The former are referred to as unmodified rays, the latter as modified rays. Whereas the width of a spectrum line in the unmodified rays is equal to that of the line in the primary rays, Compton's curves show an increased width in the modified rays. An exact expression is deduced to account for this increased width so far as it may not be accounted for by variation of the angle of scattering attributable to the finite width of the beam of primary rays. Making certain approximations, the width of the modified ray, scattered in the direction $\phi$ with the direction of the primary rays, is shown to be given by $d\lambda_\phi = 4\lambda_0 (\sin \phi/2)(\sqrt{2h/mc\lambda_s})$, in which $\lambda_0$ is the wave-length of the primary ray, $h$ is Planck's constant, $c$ the velocity of light, and $\lambda_s$ is a critical absorption wave-length of the scattering substance. This formula is shown to be in good agreement with experimental results relating to the scattering of $K_\alpha$ rays of molybdenum by carbon. The predicted width is greater than the experimental value in the case of aluminium. This is attributable in part to the comparatively large value of the binding energy in aluminium and in part to the fact that the theory has been worked out on the assumption that the electronic orbits are circular. [See Abstract 2194 (1923).] J. S. G. T.

**1400.** *Wave Theory of the Compton-Effect.* **C. Eckart.** (Phys. Rev. 24. pp. 591–595, Dec., 1924.)—It has been said that it is impossible to arrive at an interpretation of the Compton wave-length change from any wave theory. In this paper it is shown that the wave theory does in general demand a change in frequency whenever radiation passes in the neighbourhood of moving gravitating matter. The equations obtained from the wave theory are formally very similar to A. H. Compton's equations for the interaction of an electron and a corpuscle. The electromagnetic character of the wave does not enter directly into the present treatment. The calculation of the frequency change is therefore merely qualitative. Neither is the motion of the recoil electron predicted explicitly. By introducing the hypothesis that the wave is electromagnetic, the theory could be completed in these respects. However, if the electromagnetic field equations at present in vogue were made the basis of such a calculation, it seems very improbable that the results would be in agreement with experiment. The author emphasises this fact: that it is the present elec-

tromagnetic theory which is untenable, and not the wave hypothesis. In a note by **F. W. Bubb** (*ibid.*, pp. 595–596) it is pointed out that there is a very interesting similarity between the recent theory of de Broglie and the present theory. Both these views essentially regard the frequency of radiation as the time component of a vector whose properties are very similar to those of the covariant energy-momentum vector of a particle.
A. E. G.

**1401.** *The Compton-Effect with no Box around the Tube.* **P. A. Ross** and **D. L. Webster.** (Nat. Acad. Sci., Proc. 11. pp. 56–61, Jan., 1925.)—The experimental verification of a further paper's conclusion [see next Abstract] that the Compton peaks in the spectra of scattered X-rays could not be explained by Duane's box-effect theory. The details of construction of a suitable " room " as opposed to a " box " and dimensions are given, as also particulars of apparatus employed. A reproduced plate shows the results, and it is found that there is no trace of a tertiary line where Duane's peak should occur. A full discussion of the conclusions and the present status of the tertiary ray theory is given. S. G. B.

**1402.** *Compton-Effect: Evidence on its Relation to Duane's Box-Effect.* **P. A. Ross** and **D. L. Webster.** (Nat. Acad. Sci., Proc. 11. pp. 61–64, Jan., 1925.)—The paper is a concise review of all relevant data regarding the Duane theory [Abstract 575 (1925)] that with secondary X-rays, when a wooden box is placed round the tube and secondary radiator, a peak is obtained in the spectrum, hitherto explained by the Compton theory, but which is now explained by Duane as due to tertiary rays from the wood. The object of this paper is to examine the evidence in the matter obtained from Barkla's data for scattering and some earlier experiments by Ross. The arguments advanced are definitely contradictory of Duane's theory, and the peaks are only explained as yet by Compton's theory of the scattering of quanta by single electrons. The matter is treated controversially throughout. S. G. B.

**1403.** *Effect of a Surrounding Box on the Spectrum of Scattered X-Rays.* **A. H. Compton** and **J. A. Bearden.** (Nat. Acad. Sci., Proc. 11. pp. 117–119, Feb., 1925.)—Duane and his collaborators [see Abstracts 575 and 576 (1925)] have ascribed the modified lines observed when the tube and radiator were inclosed in a box to tertiary radiation from the carbon in the wood. This has been tested by Woo, who used a wood-lined and a lead-lined box and found that modified and unmodified lines appeared with about the same intensity in each case. A further test has been applied by mounting tube and radiator outside a third-floor window and photographing the spectrum with a modified Seemann spectrograph. The relative energy in the modified and unmodified lines did not differ much from that shown by Woo's ionisation spectra. F. S.

**1404.** *J Phenomena and the Quantum Theory of Scattering of X-Rays.* **R. T. Dunbar.** (Phil. Mag. 49. pp. 210–236, Jan., 1925.)—Experiments on the relative absorptions of X-rays by Cu, Al and paper show that under the experimental conditions the J-discontinuities of Barkla and White [Abstract 166 (1918)] do not appear. The results indicate that the absorption associated with scattering falls below the classical value by an amount which agrees very well with that calculated on the quantum theory of scattering of A. H. Compton. Experiments on the ionisation of $SO_2$ and ethyl bromide give no certain indication of the existence of J-discontinuities, but they give some evidence for the existence of an abnormal corpuscular emission from air such as would be accounted for by Compton's theory. Experiments on the corpuscular emission from paper, Al, Cn and Pb, as measured by ionisation of hydrogen, showed that the lighter elements emitted an additional corpuscular radiation when the wave-length of the incident radiation was short, that the energy required for the excess emission produced no apparent discontinuity in the absorption curve for paper, but they lent support to the view of Compton that a corpuscular emission would be found in association with scattering when the primary was of short wave-length. An experiment on the scattering of X-rays by filter-paper showed that the change in quality and the variation in intensity of the scattered radiation required by Compton's theory were confirmed over a considerable range of wave-lengths for scattering at right angles to the primary. From this it was deduced that the scattered X-rays were probably carrying only a fraction of the energy absorbed in association with scattering, thus strengthening the probability that the excess corpuscular emission observed in previous experiments was due to the scattering process. A. B. W.

**1405.** *Scattered Radiation due to X-Rays from Molybdenum and Tungsten Targets.* **S. K. Allison** and **W. Duane.** (Nat. Acad. Sci., Proc. 11. pp. 25–27, Jan., 1925.)—In previous experiments, in which the spectra of secondary X-radiation have been examined in the Harvard laboratory by an ionisation spectrometer, the curves show sharp peaks, having wave-lengths equal to those of the primary rays, but no peaks with wave-lengths corresponding with Compton's theory of single-electron scattering. The authors have modified the apparatus by using a water-cooled molybdenum target, sealed into a glass tube of about 3 cm. in diameter throughout, the walls being somewhat thinner opposite the target than elsewhere; a Soller multiple slit system was employed and a calcite crystal more than 9 cm. long. This arrangement greatly increases the intensity of the secondary radiation, and if the secondary radiator is placed so that only a narrow beam of primary rays produces the secondary rays, a well-marked peak, somewhat broader than that due to unshifted wave-lengths, appears, which changes its position in the spectrum, in substantial agreement with Compton's equation. The relative intensity of the shifted radiation appears to be greater for tungsten than for molybdenum. H. N. A.

**1406.** *An Application of the Quantum Theory of Band-Spectra to the First Negative Deslandres' Group of Carbon.* **C. M. Blackburn.** (Nat. Acad. Sci., Proc. 11. pp. 28–34, Jan., 1925.)—Lemon has very recently shown that only the first negative group of carbon bands is associated with the "comet-tail" spectrum [see next Abstract], and the author has studied the structure of this group. Owing to the difficulty in resolving the lines in the neighbourhood of the band heads it was difficult to assign the lines properly in accordance with the quantum theory. The structure was first worked out for two bands where resolution near the head could be obtained, and then extended to the other bands by comparison; this was possible owing to the simplicity of the bands and their similarity of structure. Taking into account the frequency due to electronic changes alone, that due to changes in the rotational quantum number $m$, and that due to changes in the vibrational quantum number $n$, a doubly infinite series of bands is deduced, the laws being followed to a very close approximation by each of the eighteen bands studied. A figure shows the fine structure of one of the bands, the rotational quantum being plotted against the wave number. Two general results may be inferred: (*a*) Owing to the simplicity of the structure the radiator of the bands very probably approximates to the dipole molecule on which the theory is based; (*b*) the absence of a Q branch is significant. On the basis of the Bohr correspondence principle such a branch only exists when the axis of rotation of the molecule has a precessional motion, so that the molecule here concerned has a simple rotation about an axis perpendicular to the line joining the nuclei. The moment of inertia before emission, in the vibrationless state ($n' = 0$, $n = 0$), is found to be $8 \cdot 07 \times 10^{-40}$ gm.-cm.$^2$, and that after emission, in the same state, is $6 \cdot 78 \times 10^{-40}$ gm.-cm$^2$., a change of about 16 % of the value in the initial state. H. N. A.

**1407.** *The "Comet-Tail" Spectrum and Deslandres' First Negative Group.* **H. B. Lemon.** (Nat. Acad. Sci., Proc. 11. pp. 41–43, Jan., 1925.)—A long vacuum tube of the Wood type, with 0·4 cm. bore, filled with 2 c.c. of helium which has been pumped by circulation through activated carbon, gives an extremely brilliant "comet-tail" spectrum if the partial pressure of the carbon compounds is of the order of $10^{-4}$ mm.; at the same time the first negative group of bands appears in the ultra-violet, and by varying the current density the two sets of bands, comet-tail and first negative, are either almost completely isolated from all other spectra or entirely suppressed; in all cases their relative intensities are qualitatively the same, and there are other indications that they originate from the same source. The spectra can be photographed in the first order of a 21-ft. Rowland concave grating, and C. M. Blackburn has recently discussed their structure from the point of view of the quantum theory of band-spectra. Apparently helium plays only a secondary rôle in the production of these spectra. [See preceding Abstract (1924).] H. N. A.

**1408.** *The Intensity of the Scattering of X-Rays by Recoiling Electrons.* **Y. H. Woo.** (Phys. Rev. 25. pp. 444–451, April, 1925.)—On the Compton hypothesis of moving electrons with a velocity in the direction of the incident ray equal to $ca/(1 + a)$, where $a = h/mc\lambda_0$, a calculation according to the usual electrodynamics when correlated with Compton's previous result, gives the same total scattering as that obtained by Thomson. The fact that experiments with very short wave-lengths do not agree with this result shows that Compton's hypothesis is not satisfactory without further modification. If we assume the virtual moving oscillators proposed by Bohr, Kramers and Slater, in view of the similarity of these to moving electrons, the result is the same, and the lack of agreement with experiment indicates that the exact form of the correspondence principle set up by these authors fails to answer the intensity problem in the scattering of X-radiation. AUTHOR.

**1409.** *Polarisation of Scattered Röntgen Rays.* **W. Bothe.** (Zeits. f. Physik, 31. 1–4. pp. 24–25, 1925. From the Reichsanstalt.)—The alteration in wave-length on the scattering of hard Röntgen rays corresponds to a simple variation of the angle of scattering of linear polarisation from the classical value. A. D.

**1410.** *Zeeman-Effect and the Dependence of Electron-Mass on the Velocity.* **W. Pauli, Jr.** (Zeits. f. Physik, 31. 5–6. pp. 373–385, 1925.)—On the assumption that the electrons of the K layer contribute essentially to the impulse-moment and to the magnetic-moment of the atom, we ought to expect an influence of electron-mass variations with velocity upon the Zeeman-effect in chemically homologous elements, particularly in the alkali metals; the Zeeman-effect would then depend notably on the atomic number. From the absence of such differences, and also on other grounds, it is concluded that the above assumption cannot be supported. A. D.

**1411.** *Intensities of Zeeman Components.* **H. Hönl.** (Zeits. f. Physik, 31. 1–4. pp. 340–354, 1925.)—The theoretical results of Sommerfeld and Heisenberg for the relative intensities of lines resolved by the Zeeman-effect, based upon Bohr's correspondence principle, are discussed, with relation to the Burger-Dorgelo rule and a general scheme of the intensities of Zeeman components enunciated. The subject is treated from a theoretical aspect, is very involved, and does not lend itself to brief abstraction. B. J. L.

**1412.** *A Short Wave X-Ray Spectrograph and Some K-Series Emission Wave-lengths.* **J. M. Cork.** (Phys. Rev. 25. pp. 197–200, Feb., 1925.)—The spectrograph described is similar to that used by Rutherford and Andrade for $\gamma$-rays. A calcite plate 1·6 mm. thick, ground with the faces perpendicular to the (100) planes, was placed midway between two slits, through one of which (3 mm. wide) it was illuminated with X-rays from the source, and through the other (0·15 mm. wide) the rays reflected from (100) planes on both sides of the axis passed to the photographic plate. A strip of lead at the middle of the crystal intercepted the direct beam. The advantages of this spectrograph are (1) that all uncertainty as to the depth of penetration into the crystal is eliminated; (2) lines are obtained whose sharpness is independent of the distance of the photographic plate; (3) all the lines of the K-series are obtained simultaneously without crystal rotation; and (4) the time of exposure may be greatly reduced by placing the crystal close to the source of the rays. The substance under investigation was placed on the copper target of a special water-cooled tube with both electrodes removable at ground joints. The lines for each element were photographed, together with tungsten lines, on both sides of the zero position. The probable error is about 0·1 X units for $K\alpha'$, $K\alpha$ and $K\beta$ and 0·3 for $K\gamma$. AUTHOR.

**1413.** *The Measurements of X-Ray Intensities for Different Wave-lengths by Photographic and Ionisation Methods.* **R. Berthold** and **R. Glocker.** (Zeits. f. Physik, 31. 1–4. pp. 259–264, 1925.)—The ratio S/I of the blackening, S, of the photographic plate and I, the saturation current in the ionisation chamber, was determined by means of simultaneous observations and plotted against the frequency. Homogeneous rays from various anti-kathodes with suitable filters were used in the experiments. The resulting graph for equal incident energy of radiation consists of three straight lines, with sudden shifts at two points, the absorption limits of bromine and silver. When S/I is plotted against the frequency for equal absorbed energy of radiation, the graph is a straight line, without any discontinuities, sloping down as the frequency increases. The results are compared with the recent photographic and bolometric measurements of Bouwers and the ionisation and bolometric measurements of Grebe and Kriegesmann, and an explanation of the differences is given. H. N. A.

**1414.** *The Investigation of the Properties of Thin Films by Means of X-Rays.* **W. Bragg.** (Nature, 115. pp. 266–269, Feb. 21, 1925. Discourse delivered before the Roy. Inst., Jan., 1925.)—This is a descriptive paper in which the molecular arrangement in films is discussed. The "black spot" phenomena of soap films is explained, and evidence goes to show that this consists of a thickness of only two molecules of oleic acid arranged with the methyl groups at the surfaces and interlocking by means of the carboxyl groups to give a purely crystalline state, in which no water of solution takes part. The subject of oil films upon water is then discussed, and evidence goes to show that these are formed of two oleic acid groups with the above interlocking. The thickness of such films is 42–52 Å.U., and the length of a molecule of oleic acid is therefore about 23 Å.U.

The measurement of the thickness of very thin films obtained by melting or pressure by means of X-ray interference phenomenon with the X-ray spectrometer is described. In such films the interlocked molecules may be either vertical or inclined to the film surface, and in some films the change from the translucent to opaque varieties—for example, candle-grease—may be explained by a change from one arrangement to the other.

The subject of greasiness of certain bodies—for example, napthaline—can be explained upon the ground of a flat molecular structure, resulting in the layers easily sliding over each other. This subject is dealt with in reference to lubrication, and the relations of molecular structure and catalysis discussed. B. J. L.

**1415.** *Complex Structure of Röntgen Spark-Spectra.* **G. Wentzel.** (Zeits. f. Physik, 31. 5–6. pp. 445–452, 1925.)—A comparison of term values of X-ray spectra with those of optical spectra of the alkalis suggests that a singly ionised shell in the interior of an atom has similar terms and possibilities of combination as a single valence electron. Various arguments are advanced for expecting a triplet series by double ionisation of an inner shell by analogy with optical spectra of similar kind. It is pointed out that the experimental proof will be difficult owing to the relatively feeble intensity of such lines in X-ray spectra, and absorption edges and excitation limits are suggested as means of detection. F. S.

**1416.** *The Photographic and Ionisation Actions of X-Rays of Various Wave-lengths.* **R. Berthold.** (Ann. d. Physik, 76. 4. pp. 409–438, Feb., 1925.)—Intensity measurements carried out by photographic methods and ionisation methods are not comparable unless we know (1) the law of photographic blackening of the silver salts with relation to wave-length, and (2) the relation between the blackening action of X-rays and the ionisation of X-rays with relation to wave-length. The first relationship has been investigated by Glocker and Traub [see Abstract 136 (1922)], and no variation of the form of the curve of blackening with the wavelength has been found. The second relation is now investigated, the experimental arrangements being described in great detail. Without the limits of absorbtion discontinuities of Br and Hg and relation of blackening S and ionisation I is found to hold as $S/I = m(47 \cdot 5 - v)$, where $m$ is a number between 0 and $\propto$ and $v$ is $10^{18}$ sec.$^{-1}$. A practical application of the method of use of this formula is given. B. J. L.

**1417.** *High-Power Rectified Current at 500,000 Volts.* **J. Saget.** (Rev. Gén. d'Él. 17. pp. 537–540, April 4, 1925.)—Diagrams and descriptions are given of two valve arrangements for obtaining high-voltage rectified current for operating X-ray tubes and producing very penetrating X-rays. The first arrangement uses two kenotrons and gives about 150,000 volts. Each kenotron is used to rectify one half-cycle of the alternating current supply. By combining two such groups in series double the voltage is obtained, and in a third arrangement the addition of two further groups enables a voltage of 500,000 to 600,000 to be obtained. A photograph is given of this latter arrangement; the output is about 5 kw. Another generator of this type, capable of an output of 15 kw., is being constructed for Perrin's laboratory at the Sorbonne. A. W.

**1418.** *The Determination by X-Ray Spectroscopy of Percentages by Weight of Various Elements in Mixtures and Compounds.* **R. Glocker** and **W. Frohnmayer.** (Ann. d. Physik, 76. 4. pp. 369–395, Feb., 1925.)—The paper is a description of the method employed by the authors for the analysis of mixtures and compounds by measurements of the intensity of the continuous spectrum on both sides of the absorption limits of the elements in the substance under investigation. The method is applicable to any solid or fluid. In order to obtain the desired results it is necessary to determine experimentally absorption constants, and the process was carried out for the K absorption limit for elements between $Z = 42$ and $Z = 90$, as well as the $L_1$ limit for those in the region of $Z = 90$. Great care was taken in the measurements of the intensity photographically, and the probable errors are assessed after considerations of their possible magnitude. The influence of the mixture of impurities was investigated, and it was found that the "jump" at the absorption limit of an element was smaller when the absorbing action of the foreign substance increased. If an element of high atomic weight is mixed with one of lower atomic weight, the former may be estimated spectroscopically with an accuracy of about ± 5 %. As practical examples of the method determinations of barium in glass, hafnium in minerals and mixtures of salts are given and the results compared with those of chemical quantitative analysis. The agreement is good. W. V. M.

## RADIO-ACTIVITY.

**1419.** *Experimental Methods for Testing Leakage of Emanation from Radium Tubes and Applicators.* **G. Barlow** and **H. B. Keene.** (Brit. J. of Radiology, 21. pp. 29–36, Jan., 1925.)—Two methods are described to control the leakage of radium tubes used for therapeutic purposes. The first method requires the undesired removal of the specimen between hospital and laboratory. This method is described and also the method

of detecting a leak in the containing tube. Since it is preferable not to have to remove the tubes from hospital to laboratory, a method is described which overcomes this objection and also permits the test to be carried out at any convenient later time. Briefly, this consists of enclosing the radium tube in a copper-foil "grid," upon which an active deposit is obtained if leakage occurs, and this grid is surrounded by a "mat" of copper-foil, having deposited upon it vegetable charcoal suspended in rubber solution, the purpose of which is to absorb emanation. This "mat" and "grid" is then removed for periodical examination in the laboratory without the necessity of removing the actual radium salt.
B. J. L.

**1420.** *On the Decay Constant of RaA.* **M. Blau.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 1–2. pp. 17–22, 1924.)—Previous results due to Curie and others since 1902 are discussed, and the tabular results obtained by the author are given and discussed. The results give values of $\lambda_A = 0{\cdot}2273 \pm 0{\cdot}0007$ min.$^{-1}$, $T_A = 3{\cdot}05 \pm 0{\cdot}009$ min. B. J. L.

**1421.** *Particles of Long Range from Polonium.* **N. Yamada.** (Comptes Rendus, 180. pp. 436–439, Feb. 9, 1925.)—Reference is made to the work of Bates and Rogers [Abstract 1501 (1924)], who found three new groups of α-particles from polonium having ranges 6·1 cm., 10 cm. and 13·1 cm. in air at 760 mm. pressure and 15° C., these particles occurring in the proportion of 9·8, 5·1 and 2·1 respectively for every $10^6$ α-particles of range 3·9 cms. The author has now repeated and extended these measurements, and finds that the results obtained vary with the nature and the surface conditions of the metal on which the polonium is deposited. It is found, contrary to the results of Bates and Rogers, that the number of long-range α-particles is not more than three or four in $10^7$ of the ordinary 3·9 cm. α-particles. A. B. W.

**1422.** *Radio-active Minerals as Geological Age Indicators.* **H. V. Ellsworth.** (Am. J. Sci. 9. pp. 127–144, Feb., 1925.)—A general review and discussion of the various radio-active methods (Ur-Pb, Ra-Pb, He-Ur ratios, etc.) of determining ages of minerals. A short abstract is not possible. A. B. W.

**1423.** *The Period of Mesothorium 2.* **W. P. Widdowson** and **A. S. Russell.** (Phil. Mag. 49. pp. 137–140, Jan., 1925.)—The period of mesothorium 2 was measured in the course of an unsuccessful attempt to isolate a second product of mesothorium 1, standing in the same relation to mesothorium 2 as uranium Z does to uranium $X_2$. The half-value period was found to be 5·95 hours (error, probably less than 1 %). This is 4 % smaller than Hahn's period of 6·2 hours. The new value of the disintegration constant is 0·116 per hour. Details of the chemical methods used for separating out the mesothorium 2, together with its hypothetical isotope, are given; in none of the preparations was any abnormal initial decay observed, and the active material decayed exponentially to zero. This shows that there is no appreciable quantity of a minor isotope with a period between three minutes and six hours. Preliminary experiments indicate that the existence of a product with a greater period is also unlikely. H. N. A.

## HEAT.

**1424.** *Some New Methods for the Measurement of Thermal Conductivity.* **T. Barratt** and **R. M. Winter.** (Phil. Mag. 49. pp. 313–322, Feb., 1925.)—In an earlier paper one of the authors has shown [see Abstract 1991 (1914)] that the thermal conductivity of a thin rod can be expressed as $k = (H^2/pqhV^2) \coth^2 \alpha l$, or when the rod is long $k = H^2/pqhV^2$, wherein H = the heat supplied in calories per second to the hot end of the rod, at which the temperature difference between the rod and its surroundings is V degrees C.; $p$ = perimeter of rod in cms.; $q$ = area of cross-section in sq. cms.; $l$ = length of rod in cms.; $\alpha = \sqrt{hp/qk}$; and $h$ is the emissivity of the surface. The uncertain and troublesome part of the measurements required to determine $k$ is that involved in finding $h$, since this factor depends on a number of important conditions difficult to take completely into account. The present paper describes new methods, based on those of the earlier paper, in which $h$ is entirely eliminated from the formulæ, thus removing the necessity for measuring it. The general equation for the fall of temperature along a rod is first solved in a general way, the solution being transformed so as to give $k$ in terms of H, $q$, $\alpha$, V, and the temperature excess at any other point along the rod. The resulting expression is not explicit, but can easily be solved graphically, a numerical example illustrating the procedure in a typical case. From the general expression a simple formulæ for $k$ is found requiring merely the measurement of H, the temperature at the hot end of the rod, the cross-section, and the temperature at any other point along the rod. Formulæ are also found in the cases when (i) $h/k\alpha$ is small; (ii) $q$, $l$, H, V and V′, the temperature excess at the cold end, are specified together with condition (i); (iii) the ratio H/V is known for two values of $l$. Finally, a formula for $h$ is found under the conditions specified in (ii). B. H.

**1425.** *The Thermal and Electrical Conductivities of some Pure Metals.* **F. H. Schofield.** (Roy. Soc., Proc. 107. pp. 206–227, Feb. 2, 1925.)—Earlier research on thermal conductivity has been over temperatures from 100° C. down to below −250° C., and the object of the present investigation was to extend to 700° C. the measurements of thermal and electrical conductivities of a number of metals of the highest purity obtainable commercially. The guard ring method was employed, steady conditions being obtained in the specimen and lateral heat losses reduced to low values. The specimen, in the form of a cylindrical rod, was heated by a Pt coil wound on a silica rod placed in a cavity at its centre, and Cu rods screwed into its ends served as sinks. Various devices were employed to increase or decrease the heat losses from these ends. Temperatures along the rod were obtained with thermocouples of Pt and 10 % Ir-Pt. An accuracy of 1–2 % was obtained. Electrical conductivities were measured by a comparison of the voltage drop along the specimen and a standard resistance in series with it. The results obtained for both conductivities and for Lorenz's function are compared with those of Jäger and Diesselhorst, Lees, Angell, Konno, and Honda and Shimidu. It was found that the thermal conductivity of Al increased with rising temperature. Ni decreases at first, but above 500° C. rises, while Cu, Mg and Zn show a slight decrease with rising temperature. For Lorenz's function, Cu, Mg and Zn are practically constant at all temperatures. Al rises with increasing temperature, while Ni increases up to 300° C., and is nearly constant above, with an abnormal value at 400° C. R. S. R.

**1426.** *Thermal Expansion of Aluminium and Various Important Aluminium Alloys.* **P. Hidnert.** (Bureau of Standards, Sci. Papers, No. 497. pp. 697–731, 1925.)—This paper gives data on the linear thermal expansion of four samples of aluminium and 51 samples of important aluminium alloys. The preparation, chemical composition, heat treatment, etc., are included. Most of the specimens were examined from room-temperature to about 500° C. Typical expansion curves of the various groups of samples are shown and discussed. A description of the apparatus used in this research and a review of available information obtained by previous observers on the thermal expansion of aluminium and some of its alloys are given. AUTHOR.

**1427.** *Specific Heat of Liquids.* **R. N. Ghosh.** (Indian Chem. Soc., J. 1. pp. 123–124, Dec. 31, 1924.)—Honda's formula [see Abstract 706 (1923)] for the specific heat of liquids, based on the rotational energy of the molecule, having been shown insufficient to account for the high values obtained experimentally, a new empirical formula is proposed for the energy of the liquid per unit mass of the form $E = 3NkT + Nx/2(e^x - 1)$, where $x = h\nu_1/kT$, N = number of atoms per unit mass, T = abs. temp., $h$ and $k$ are Planck's and Boltzmann's constants respectively, and $\nu$ is obtained from Lindemann's formula. A table is given comparing calculated and experimental results, the former being in general low. A corrective formula involving compressibility values for which data are unavailable is tentatively suggested. A. B. C. L.

**1428.** *Pipe-line Temperature Measurements.* **E. S. Bristol.** (Optical Soc. of America, J. and Rev. Sci. Inst. 10. pp. 243–251, Feb., 1925.)—An examination of the errors involved in applying electrical temperature indicators to commercial superheated steam-pipe lines is recorded and the relative values of various forms of apparatus from the standpoints of accuracy and serviceability are determined. After giving full experimental details, the paper tabulates results of work with platinum resistance thermometers and copper-constantan thermocouples. The conclusions applying to lagged superheated steam-pipe conditions are: (1) Under worst conditions a 16 B and S gauge copper-constantan or iron-constantan thermocouple will reach − 10° F. error. (2) This can be reduced by encasing the couple in a bright nickel tube, as long as the tube is bright and polished. (3) A 22-gauge couple may have a maximum accuracy of − 2° F. (4) A platinum resistance thermometer with an undarkened cover surface will have a maximum error of − 5° F. under worst conditions. The latter is therefore regarded as most efficient. A brief note on the mixing of steam to avoid stratification is given for purposes of temperature measurement and also the choice of a suitable position for recording instruments away from outlets, etc. S. G. B.

**1429.** *Platinum Resistance Thermometry at Low Temperatures.* **M. S. van Dusen.** (Am. Chem. Soc., J. 47. pp. 326–332, Feb., 1925.)—Below the region − 40° C. temperatures defined by the Callendar equation depart from the thermodynamic scale by amounts which increase very rapidly below − 100° C., the calculated temperatures being 2° too low at liquid-air temperatures. A simple modification of the Callendar equation for platinum resistance thermometry above 0° C. is given, which will express accurately the resistance of platinum on the thermodynamic scale from 0° C. to − 190° C. The revised equation contains an additional term,

$$t = \frac{1}{\alpha}\left(\frac{R}{R_0} - 1\right) + \delta\left(\frac{t}{100} - 1\right)\frac{t}{100} + \beta\left(\frac{t}{100} - 1\right)\frac{t^3}{100^3}$$

The last term is omitted for temperatures above zero. $\beta$ is determined by calibration at or near the boiling-point of oxygen, and $\alpha$ and $\delta$ as in ordinary work. The new equation requires but one calibration below zero. Recalculations of data on resistance thermometers at low temperatures obtained at the Reichsanstalt and the Bureau of Standards are made and tabulated showing that the modified equation expresses the experimental results within the errors of observation. S. G. B.

**1430.** *The Davos Frigorimeter. An Instrument for Permanently Registering the Extent of Physiological Cooling.* **R. Thilenius** and **C. Dorno.** (Meteorolog. Zeits. 42. pp. 57–60, Feb., 1925.)—A new instrument for which freedom is claimed from defects inherent in those hitherto employed. A black copper sphere 7·5 cm. in diameter, into which a small controlling thermometer is inserted, is mounted by means of a metal tube about 1 cm. in diameter and 8 cm. high on a metal plate, and provided with a conducting cable and plug. Separated from it is a wooden stand carrying a powerful clock about 12 cm. in diameter and 11 cm. high, with plug contact and relay, and two resistances. Another conducting cord leads to relay and clock, and is connected by a plug to the conducting net. The clock goes only when a current is directed to the heating body. The relation between the time indicated by the clock ($t_1$) and the interval between the readings ($t_2$) multiplied by the factor given by instrument ($f$) gives the extent of the cooling (A) in 1/1000 g.-cal. per sq. cm. and second, so that $A = t_1/t_2 \, . \, f$. The following are among the advantages claimed for the instrument: The rapidity of the exchange of temperature with the air is, in proportion to the conductivity of copper compared with glass (0·90 : 0·002), 450 times greater than with the kata-thermometer. The spherical form ensures uniform radiation in all directions. The sphere has a surface area about 6·2 that of the kata-thermometer, therefore approximates more to the dimensions of the human body. Its chief merit lies, perhaps, in the fact that the degree of cooling may be directly deduced from its physical values, so that it may be described as an instrument of absolute measure. It measures continuously in the manner employed by Hill for gauging the kata-thermometer. A temperature of 33° is chosen for the measuring body, *i.e.* the heat of the skin at room temperature calculated from Vincent's formulæ. The instrument is arranged for working with alternating or constant current. A full description is reserved pending the granting of a patent. E. F.

**1431.** *Destruction of the Berthelot Calorimetric Bomb and its Replacement by a Bomb of New Type.* **C. Moureu.** (Comptes Rendus, 180. pp. 557–560, Feb. 23, 1925.)—The circumstances of the destruction by explosion of the original Berthelot calorimetric bomb are detailed, and the very considerable cost involved in its replacement by an exact copy, owing to the large quantity of Pt employed in the lining and joint, is referred to. In the type ultimately adopted, a saving of Pt is effected by narrowing the neck of the bomb, and by substituting a composite lining composed of Cu (0·4 mm.), Au (0·4 mm.), and Pt (0·2 mm.), intimately associated, the Cu being next to the steel wall of the bomb. By these means the amount of Pt required is reduced to less than 10 % of that employed in the original. The new apparatus is stated to have yielded entirely satisfactory results. A. B. C. L.

**1432.** *Fusion and Evaporation of Graphite.* **E. Ryschkewitsch.** (Zeits. Elektrochem. 31. pp. 54–62; Disc., 62–63, Feb., 1925.)—As in the previous experiments [Abstracts 220 (1922) and 969 (1924)] with carbon, the author places a rod of graphite (obtained by heating to 2500° C. a carbon rod for several hours while embedded in powdered graphite), 5 cm. long, 3 mm. in diameter in the thinner middle portion, vertically between blocks of graphite into which the graphite terminals of alternating current leads are screwed. The whole apparatus is enclosed in a glass bulb, through which argon is kept flowing; the gas pressure ranges from 0·02 to 1·5 atmo. As the temperature of the rod rises a bright ring suddenly develops in the central horizontal plane; in the next moment the rod splits along that plane, and an arc is formed which is soon extinguished. Kinematograph pictures, taken at intervals of 1/25 second, are reproduced (but wrongly marked, as corrected on p. 160). At the moment of rupture the inner wall of the protective cylinder surrounding the road becomes covered with soot in which some globules up to 1 mm. diameter, apparently of fused graphite and of the correct density 2·232, can be distinguished. The rupture might be due to bursting or to fusion. A gradual evaporation of the graphite, leading to an internal bursting, should become visible. The author hence concludes that the graphite is really fused. The temperature suddenly rises as the rod fuses owing to the arc formation, and then drops, while the current density (up to 2100 amp./cm.$^2$) decreases, first suddenly and then slowly. The melting-point of graphite is estimated at 3800 ± 100°, that is, 400° lower than the temperature of the positive carbon arc crater at 1 atmo. The author suggests that the crater is covered by a thin film of liquid carbon. His graphite contains 0·1 % of mineral impurities. The heat of evaporation of carbon is found to be about 92 cal./mol., *i.e.* lower than that of Kohn and Guckel [Abstract 3034 (1924)], 133 cal., which the author considers to be more probable. The *Discussion* by **H. Fischer, Bodenstein** and **Amberg** concerned the identification of the globules (only the density was determined); **F. Sauerwald** ascribed them to impurities, and asked why indications of incipient fusion were never observed in the interior of carbon rods, while found in tungsten rods. **Errata** (*ibid.*, p. 160, March, 1925). H. B.

**1433.** *Fusion and Heat of Evaporation of Graphite.* **K. Fajans.** (Zeits. Elektrochem. 31. pp. 63-70, Feb., 1925.)—The author, in whose laboratory the experiments of Ryschkewitsch [see preceding Abstract] were made, further discusses the reasons which induce him to believe that there is fusion of the graphite, and not merely of impurities which (Sauerwald) might have become concentrated on the surface and have lowered the melting-point of the carbon. At 1/3 atmo. the positive carbon arc is covered with a very thin film of liquid carbon (possibly 0·2 mm. thick). What is measured is therefore not the heat of sublimation of solid carbon, but the boiling-point of the liquid phase at 5 atmos. Kohn and Guckel found the crater temperature to be 4700°. These views would explain the apparent contradictions in Lummer's statements on the liquefaction of carbon. Taking the latent heat of fusion of graphite at 10 cal., the heat of sublimation of diamond (Kohn and Guckel) would be 147 cal. at ordinary temperature. For the determination of the vapour pressure curve the measurement of the crater temperature seems more suitable than the observation of the rate of evaporation of carbon filaments. H. B.

**1434.** *Temperature of Vapour arising from a Solution.* **W. Möbius.** (Zeits. techn. Physik, 6. 2. pp. 58–60, 1925.)—Schreber [Abstract 1176 (1923)] concluded from his experiments that the temperature of the vapour arising from a boiling solution was that of the boiling-point of the pure solvent. He also accounted theoretically for the abrupt temperature change at the surface of the solution. The experiments of Knoblauch and Reiher led them to conclude that the temperature of the vapour when it leaves the solution is that of the boiling-point of the solution. The author has determined the temperature of the vapour arising from a boiling aqueous solution of $CaCl_2$. He finds that when an ordinary boiling-point apparatus is employed (boiler surmounted by two concentric copper cylinders) the thermometer in the vapour always records the temperature of the boiling-point of the solvent. If, however, the double-walled copper cylinder be replaced by three concentric cardboard cylinders, then the temperature given by the thermometer in the vapour is 6°·6 above the boiling-point of the water. The boiling-point of the solution was 10°·6 above this temperature. The author concludes that the vapour leaves the solution at the temperature of the solution boiling-point, and the thermometer would record this temperature if cooling of the vapour could be wholly prevented. L. L.

**1435.** *Recent Measurements of the Joule-Effect for $CO_2$.* **J. G. Keyes** and **F. W. Sears.** (Nat. Acad. Sci., Proc. 11. pp. 38–41, Jan., 1925.) —Deduces an expression for the change of temperature when a given volume of $CO_2$ expands into a vacuum, which includes the effect of the work done against the mutual attractive forces of the molecules and that done in altering the number of associated molecules; and describes an experimental method in which a 2-litre flask is used, to which a steel rim is cemented and a cover ground on. The $CO_2$ is contained in a glass tube, placed axially in the flask, and surrounded by a thin walled steel tube perforated with small holes, which prevents the fragments of the glass tube from being projected outwards when it is broken by the point of a screw passing through the steel cover. The following table shows the results, the first column giving the pressure in atmospheres in the glass bomb, the second ΔT obs., and the third ΔT calc. :—

| | | |
|---|---|---|
| 16·5 | 0·17° C. | 0·12° C. |
| 13·3 | 0·08° C. | 0·07° C. |
| 15·6 | 0·06° C. | 0·09° C. |

The temperature changes are of the expected order of magnitude. Temperatures were measured by determining the resistance of a platinum wire, wound on insulating vanes round the inner steel tube, or by means of a thermocouple. H. N. A.

**1436.** *Molecular Association and the Equation of State of Gases.* **A. Leduc.** (Comptes Rendus, 180. pp. 502–505, Feb. 16, 1925.)—In papers published in 1897 and 1899 the author calculated the proportion of twinned molecules in anomalous vapours, normal gases being assumed to consist of a single kind of molecule at all temperatures and pressures. To-day association is sometimes regarded as a general phenomenon, which is exaggerated in anomalous vapours. J. Duclaux has recently treated the case by supposing that of the N molecules forming 1 gramme molecule $2n$ have twinned to form $n$ double molecules, the system forming a mixture of two perfect gases, to which Dalton's law can be applied, and arrives at a formula connecting pressure and temperature which confirms the author's results, which are based on kinetic conditions. For $CO_2$ the values of $f$, the fraction of the molecules which are twinned, and of Q, the heat of formation at constant volume of a double gramme molecule, are as follows at atmospheric pressure :—

| Temp. ......... | −80° C. | 0° | 100° | 200° | 300° | 500° |
|---|---|---|---|---|---|---|
| $f$ ............... | 0·0378 | 0·0170 | 0·0095 | 0·0063 | 0·0048 | 0·0032 |
| Q .............. | 944 | 1063 | 1237 | 1421 | 1608 | 1992 |

It will be seen that $f$ is about 4 % for the saturated vapour, and the variation of Q is almost linear between 0° and 500°. $f$Q tends towards zero when T increases without limit. H. N. A.

**1437.** *The Temperature-entropy Diagrams for Nitrogen and Oxygen.* **W. H. Rodebush, J. W. Andrews** and **J. B. Taylor.** (Am. Chem. Soc., J. 47. pp. 313–319, Feb., 1925.)—This paper records the devising of a method with full experimental details for the measurement of the heat content of a liquid as a function of temperature and pressure analogous to the total heat determinations made for the determination of mean specific heats at high temperatures. When the total heat quantity measured is large, the errors due to heat leakage are minimised. The temperature-entropy diagrams of nitrogen and oxygen have then been constructed. [See Abstract 1439 (1920)]. H. H. Ho.

**1438.** *Criticisms of Eucken's Work on the Entropy of Condensed Gases at the Absolute Zero.* **F. Simon.** (Zeits. f. Physik, 31. 1–4. pp. 224–228, 1925.)—A summary is given of Eucken's work on this subject [see Abstracts 157 and 165 (1925)] and the results criticised on the following grounds: When dealing with monatomic molecules possessing a regular crystalline structure considerable difficulties arise when extrapolating the specific heat to the absolute zero. For atoms with more than one molecule the conditions are complicated by molecular vibrations in the lattice, torsional vibrations in the molecule and vibrations of the atoms in the molecule. At very low temperatures the last named is negligible, but the second can possess a small value, and this will increase the probable error in Eucken's values. Molecular vibrations will also affect the results, and thus more exact values of the specific heats at these low temperatures are necessary before rejecting the applicability of the Nernst theorem. Other physical properties may have to be considered at these low temperatures to prove the existence of the supposed molecular states. Finally, the numerical values employed by Eucken are criticised and the deviation of the chemical constant of $H_2$ from the theoretical value shown to be unjustified. R. S. R.

**1439.** *The Quantum Theory of the Monatomic Perfect Gas. Part II.* **A. Einstein.** (Preuss. Akad. Wiss. Berlin, Ber. 1. pp. 3–14, 1925.)—Bose's theory of the degeneration of a perfect gas based on a profound connection between radiation and gas is first referred to, since the degenerate gas differs from the gas of mechanical statistics in analogous manner as radiation, according to the Planck conception, differs from that of Wien. Further considerations now advanced show that the analogy between quantum gas (radiation) and molecular gas must be complete, and the earlier paper [see Abstract 159 (1925)] is therefore supplemented by the following treatment: § 6. The saturated ideal gas; § 7. Comparison of the present gas theory with that which follows from the hypothesis of the reciprocal statistical independence of the gas molecules; § 8. The variation properties of the perfect gas; § 9. The viscosity of gases at low temperatures; § 10. Equation of state of the saturated perfect gas. Notes on the theory of the equation of state of gases and on the electronic theory of metals; § 11. Equation of state of the unsaturated gas. H. H. Ho.

**1440.** *On the Quantum Theory of the Perfect Gas.* **A. Einstein.** (Preuss. Akad. Wiss. Berlin, Ber. 3. pp. 18–25, 1925.)—The derivation of the Planck radiation formula by Bose based on the light quantum hypothesis, has led the author to propose a quantum theory of the perfect gas now described. This theory appears valid on the basis that a light quantum (apart from its polarisation property) only differs from a monatomic molecule in that the static mass of the quantum is vanishingly small. Since previous statistical methods are by no means objection-free, the author has made the argument as far as possible independent of arbitrary hypotheses. In § 1 the problem is mathematically stated. § 2 considers why the classical equation of state does not fit into the quantum theory. § 3 is devoted to dimensional considerations, including the method employed in the paper. § 4 deals with adiabatic compression, and § 5 with a gas in a conservative force field. § 6 contains conclusions on the equation of state of the perfect gas. In § 7 the relationship is discussed of the result of § 6 to the classical theory and to the quantum theory now proposed. Two objects have been attained in this investigation, *viz.*: (1) A general condition has been found which every theory of the perfect gas must satisfy. (2) The equation of state derived cannot be destroyed by adiabatic compression or by conservative fields of force. H. H. Ho.

## SOUND.

**1441.** *The Production of Sub-Harmonics.* **W. N. Bond.** (Phil. Mag. 49. pp. 236–240, Jan., 1925.)—A detailed discussion of the sub-harmonic notes produced by the intermittent contact of a tuning-fork and a suitable solid body as previously described and demonstrated in *Nature*, 113. p. 355, March 8, 1924. If a large tuning-fork is energetically sounded and part of the stem or the basal end of its prongs is touched lightly against a fixed solid body, the note produced has a frequency equal to that of the fork divided by an integer. Five different notes can be obtained according to the amplitude of the fork vibrations or the force with which the fork presses against the rigid body. The intermittent contacts are included in an electrical circuit, including an ammeter, and a cell and a telephone. The ammeter records different mean currents for each sub-harmonic, and the microphone gives the corresponding note. The contacts are also graphically recorded, and a plate of results is given and discussed. The method affords a means of determination of fork frequencies without microphonic or stroboscopic apparatus. S. G. B.

**1442.** *Non-radial Harmonic Vibrations within a Conical Horn.* **V. A. Hoersch.** (Phys. Rev. 25. pp. 218–224, Feb., 1925.)—Simple harmonic vibrations satisfying the equation $\phi = (kr)^{-\frac{1}{2}} \mathrm{J}_{m+\frac{1}{2}}(kr) \mathrm{P}_m (\cos\theta) \cos\sigma t$ are studied. In this equation, $\phi$ is the velocity potential, J and P denote Bessel and Legendre functions respectively, and $r$ and $\theta$ are polar coordinates. The parameter $m$ specifying the orders of the Bessel and Legendre functions is determined so that the vibrations satisfy the boundary conditions for a conical horn. This is possible by means of a new expansion for $\mathrm{P}_m(x)$ which is herein developed. With the assumption of a loop at the opening of the horn and by the aid of an asymptotic expansion for $\mathrm{J}_{m+\frac{1}{2}}(z)$, numerical values are computed, for horns of various angles (2° to 30°) and for two types of vibration, of the ratios $n/n_0$ of several frequencies to the fundamental frequency $n_0$, and of the ratios $\lambda/d$ of the corresponding wave-lengths to the diameter of the horn at the opening. The nature of these two types of vibration is indicated by figures. AUTHOR.

**1443.** *Theory of the Optimum Angle in a Receiving Conical Horn.* **V. A. Hoersch.** (Phys. Rev. 25. pp. 225–229, Feb., 1925.)—A theoretical explanation of the fact that maximum amplification is obtained if the horn has a certain *optimum angle* is presented. The horn of small angle $\theta$ is assumed to be resonating to plane waves of frequency $2\pi\omega$ which come to its large end in the direction of the axis. Putting the energy flux through the small opening at the apex equal to the net flux into the large end, we obtain $(2\pi/\rho)\theta^2\mathrm{P}_1 = (n\pi^2/\rho)\theta^4\mathrm{P}_2 + (2\omega^3/n\pi a)y_2\mathrm{P}_2$; hence the equation for the amplification is $\mathrm{P}_2/\mathrm{P}_1 = \theta^2/[\frac{1}{2}n\pi\theta^4 + (\rho\omega^3/n\pi^3 a)y_2]$, where $y_2 =$ the admittance at the vertex (reciprocal of impedance), $\rho =$ density, $a =$ speed of sound, $n =$ order of harmonic 1, 2, 3 . . . This is a maximum for $\frac{1}{2}n\pi\theta^4 = (\rho\omega^3/n\pi^2 a)y_2$; and from the energy equation we see that for the optimum angle the energy dissipated from the large end equals that dissipated from the vertex, the total net input being twice each. AUTHOR.

# ELECTRICITY AND MAGNETISM.

## THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

**1444.** *New Electromagnetic Law.* **Ferrier** and **L. Besnerais.** (Comptes Rendus, 180. pp. 573–576, Feb. 23, 1925.)—The authors claim that they have shown that by assuming that two electric particles exert equal and opposite action one upon the other of magnitude $dW/dr$, where $W = e^2/r \cdot F(u, \ldots)$, $u$ is the velocity of an electron and $F(u) \equiv 1 - u^2/2 + \ldots$, the first term of which is due to Weber, it is possible to conceive an electric ether consisting entirely of particles of the same sign. In the present paper they claim to have shown that this formula permits of the interpretation, not only of known electromagnetic phenomena, but also of hitherto unexplained phenomena of radio-activity. G. W. DE T.

**1445.** *Electrostatic Attraction.* **H. Schering** and **R. Schmidt.** (Zeits. techn. Physik, 6. 1. pp. 19–27, 1925. From the Reichsanstalt.)—Experiments on the attraction between two condenser plates separated by a solid dielectric show an apparent deviation from Coulomb's law. This deviation may be accounted for by assuming the existence of a thin layer of air between the dielectric and the plate. If the fit between the two were perfect, the attraction between the plate and dielectric due to electrostatic action would be masked by molecular adhesion; but if—as is invariably the case—actual contact is confined to a few points only, the layer of air which separates the plate and dielectric over the greater portion of the surface causes, in the case of a highly insulating material like sulphur, a greater attraction than that corresponding to a liquid dielectric having the same dielectric constant; the attraction does not vary greatly with the thickness of the layer of air, so long as this is small. If the dielectric exhibits surface conduction, while its interior is highly insulating (as in the case of glass), the application of an alternating p.d. produces a similar effect, but with a continuous p.d. this vanishes. In the case of a poor insulator, such as slate, the attraction with continuous and low-frequency alternating p.d.'s becomes very great (Johnsen-Rahbek effect), as owing to conduction the surface of the semi-conductor acquires a potential which results in a p.d. between it and the plate nearly equal to the full impressed p.d.; the attraction in this case depends essentially on the thickness of the layer of air, and is almost independent of the electric properties of the medium and of its thickness; with increase of frequency, the attraction rapidly decreases. In the case of ordinary glass, all the above effects may be produced by varying the temperature. The authors give the results of experiments carried out on sulphur, Minos glass, slate, and ordinary glass maintained at various temperatures. A. H.

**1446.** *Measurements in the Millikan Condenser.* **Y. C. Yang.** (Ann. d. Physik, 76. 4. pp. 333–368, Feb., 1925.)—This paper is divided into two main sections. In the first the oscillating movements of very small particles in an alternating electric field are investigated. Within the scope of the velocities used in these experiments the results are in complete accord with the theory and results of earlier experimenters. The mobilities with uniform and with oscillating movement differ from one another only unessentially. In the second part the influence of an alternating tension at the plates of a Millikan condenser on the photoelectric effect on particles of an ultra-microscopic order of magnitude is investigated. In accord with the theory of Meyer and Gerlach it is found that there is an essential increase in the maximum attainable end charge of the particles by the application of the alternating tension. This end charge as a function of alternating tension is both experimentally determined and is calculated from theory. The time of lag in relation to the charges of particles is investigated. The application of the alternating tension lowers the time of lag. A. E. G.

**1447.** *The Theory of a Simple Electrostatic Alternator.* **A. W. Simon.** (Phys. Rev. 25. pp. 368–375, March, 1925.)—The quantitative theory of a simple electrostatic alternator, that is a static machine which reverses its potential periodically, is given. The machine studied is one with four fixed inductors and four revolving carriers, and reverses its potential once every revolution. Assuming there is no leakage, the formulas for the potentials of the inductors are deduced; and, provided the potentials of two opposite inductors were initially zero and those of the other pair equal and opposite, take a very simple form. If the inductors nearly completely surround the carriers and if the inductors are relatively far apart, during every revolution the potential of any inductor is theoretically quadrupled and at the same time reverses its sign. The machine is therefore self-exciting. Experiments made with an actual machine are described and are in good qualitative agreement with the theory. AUTHOR.

**1448.** *Classification and Thermodynamic Properties of Atmospherics.* **R. Bureau.** (Comptes Rendus, 180. pp. 529–532, Feb. 16, 1925.)—Atmospherics in France may be classified into the following types according to simultaneous meteorological conditions: (1) Associated with the polar front—sharp isolated discharges, lengthening into cracklings after the passage of the discontinuity; these are always connected with the motion of the cold air. (2) Occurring in pseudo-polar fronts—incessant rumblings which occur between 11 and 21 hours. (3) Associated with currents derived from the polar front; usually severe atmospherics very similar to those in type 1. (4) Anticyclonic atmospherics; these are generally less severe than the other types and always occur at night. [See Abstract 3029 (1924).] A. W. L.

## DISCHARGE AND OSCILLATIONS.

**1449.** *The Abnormally Low-Voltage Arc in Mercury-Vapour, Argon and Helium.* **R. Bär.** (Zeits. f. Physik, 31. 5–6. pp. 430–438, 1925.)—The method used in the investigation was similar to that of Yao, the arc passing from the incandescent wire kathode to the mercury anode at the bottom of a flask-shaped bulb, which could be heated in a paraffin bath or an electric oven. A temperature of more than 150° C. was necessary to obtain an abnormally low-voltage arc; at 175° C. the smallest voltage at which the arc burnt was 3·5 volts; that there were no oscillations was shown by connecting a capacity in parallel to the arc, no alteration was produced in current or voltage; the "peak" voltage was also measured by the method of Bär, v. Laue and Meyer, and was found to be equal to that given by the continuous current voltmeter. The above figure, 3·5 volts, includes the voltage used up in the connections, eliminating this the lowest voltage obtained with a very hot kathode was 2·25 volts. The author has also succeeded in obtaining an abnormally low-voltage arc in helium without oscillations, the lowest voltage being 16·5 volts, including the drop in the incandescent wire. This result was obtained in very pure helium by heating the tungsten wire kathode to the highest possible temperature. With argon the arc was obtained with 4 volts p.d. measured from the negative end of the incandescent wire. H. N. A.

**1450.** *Low-Voltage Arcs in Phosphorus Vapour.* **O. S. Duffendack** and **H. Huthsteiner.** (Phys. Rev. 25. pp. 501–508, April, 1925.)—Low-voltage arcs were struck in phosphorus vapour obtained by heating pure red phosphorus to about 335° C. in a discharge tube. The minimum arcing potential was found to be 10·3 volts. This is also the voltage at which ionisation begins in a vapour containing a high percentage of atomic phosphorus. The monatomic gas is obtained by heating a molybdenum box-shaped anode by radiation from tungsten filaments mounted inside it. It is concluded that this is the ionising potential of the phosphorus atom. The relation of these results to those of previous observers is discussed. The spectrum of the low-voltage arc contains both lines and bands. The lines are those of the arc spectrum of phosphorus, and are probably due to atoms formed by dissociation at the filament. Both lines and bands exhibit the same changes in relative intensity in different parts of the arc and in arcs at 12 and 48 volts. AUTHORS.

**1451.** *Electric Currents through Short Distances between Metallic Electrodes in Vacuo.* **H. Rohmann.** (Zeits. f. Physik, 31. 1–4. pp. 311–325, 1925.)—The author has investigated the relation of current to potential difference across metal electrodes separated by short distances of the order 10 $m\mu$ to 1000 $m\mu$ *in vacuo*. The results indicate that in the case of electrodes at a constant distance apart, the value of the applied potential corresponding to effective contact between the electrodes, *i.e.* the "binding potential," is within wide limits independent of the current strength, and proportional to the distance apart of the electrodes. For lower values of the potential the gap is perfectly insulating. The observation of this "binding potential" affords a convenient means of determining the critical field strength of the discharge between the electrodes, which in general decreases with continued evacuation of the vessel in which the discharge occurs. In the case of two electrodes of different metals the value of the "binding potential" is independent of the direction of flow of the current; moreover the value of the critical field strength is the same for different metals which have been submitted to the same treatment. J. S. G. T.

**1452.** *Liberation-Energy of Positive Ions.* **A. Günther-Schulze.** (Zeits. f. Physik, 31. 7–8. pp. 507–508, 1925.)—Data given for a number of metals. A. D.

**1453.** *Theory of Layer Discharge.* **A. Günther-Schulze.** (Zeits. f. Physik, 31. 1–4. pp. 1–13, 1925.)—The paper reviews the earlier theories and develops the theory of layer discharge by the aid of known laws of electron movement in gases. The conditions under which the space discharge, caused by the change of velocity of the electrons, passes into the layer discharge, are investigated. For the details the original paper must be consulted. F. J. B.

**1454.** *A Critical Resistance for "Flashing" of Air Discharge-tubes.* **J. Taylor** and **W. Clarkson.** (Phil. Mag. 49. pp. 336–353, Feb., 1925.)—In a previous paper [see Abstracts 2569 (1924), 203B and 404 (1925)], the writers showed, in the case of the neon discharge-tube or "Osglim" lamp, that there was a critical resistance below which the well-known phenomenon of "flashes" could not be obtained. The relation for this critical value is of the form $R_c = (E - V_b)/k(V_b - V_a)$ where E is the charging voltage, $V_b$ is the lower critical voltage, $V_a$ the cathode fall of potential approximately, and $k$ the "conductance" of the lamp. The condition for no flashes is expressed physically by the fact that during any instant of the discharge through the tube, the quantity of electricity flowing from the condenser is exactly equal to the quantity which flows into the condenser from the charging battery. Some results were put forward tentatively in support of the above equation. The results were, however, neither definite nor conclusive, and a fuller investigation into the problem of the critical resistance of air discharge-tubes is considered necessary. In the present paper the following points are dealt with: (*a*) The generalised form of the critical resistance function for the discharge-tubes; (*b*) the variation of $V_b$ under different conditions; (*c*) the variation of $V_c$ with the capacity C; (*d*) the critical resistance relations for large capacities of the order of 1 microfarad; (*e*) the pressure-range over which "flashes" may be obtained; (*f*) the critical resistance relations for small capacities of the order of $10^{-1}$ microfarad; (*g*) the variation of $R_c$, $V_b$, etc., with C; (*h*) the variation of the effective lower critical voltage $V_b^1$. A. E. G.

**1455.** *The "Flashing" Phenomena of Certain Types of Discharge-tubes.* **J. Taylor** and **W. Clarkson.** (Univ. of Durham Phil. Soc., Proc. 7. 1. pp. 1–13, 1923–1924.)—The "flashing" of discharge-tubes was first described for the case of the "Osglim" lamp by Pearson and Anson. The present writers extended the study of flashing to the cases of air discharge-tubes over a wide range of pressures. In the present paper the subject is dealt with under the following heads: The upper and lower critical voltages; the phenomenon of "flashing"; the general problem of the effect of resistances on the flashing of discharge-tubes; the experimental relations; the variation of the upper and lower critical voltages; the resistance conditions necessary for the maintenance of flashing in discharge-tube circuits; the experimental relations for the critical resistances; variations of D, the slope of the E, $R_c$ graphs, with $r$; the critical resistances for air discharge-tubes; the variation of the critical resistances with capacity. [See also Abstract 2569 (1924) and preceding Abstract.] A. E. G.

**1456.** *Volt-Ampere Characteristics of Low-Tension Discharge-tubes in which the Electrodes are Near Together.* **J. Taylor.** (Univ. of

Durham Phil. Soc., Proc. 7. 1. pp. 14–29, 1923–1924.)—Low-tension discharge-tubes present many and interesting problems. One of the chief is the form of the volt-ampere characteristics. In the early work on discharge tubes the distance apart of the electrodes was usually great (10 cm. or more) and the positive column with its concomitant phenomena were present. The effect of the accumulation of charge on the walls of the tube was considerable and could not be allowed for, so that the results were on the whole neither reliable nor repeatable. The type of discharge dealt with in the present paper is obtained in tubes in which the electrodes are only some mms. apart and the positive column is absent. Under these conditions there is the usual Crook's dark space, negative glow, and Faraday dark space. Under certain conditions there is also an anode glow. [See Abstract 404 (1925).] A. E. G.

**1457.** *Diffusion of Electrons against an Electric Field in the Non-oscillatory Abnormal Low-Voltage Arc.* **K. T. Compton** and **C. Ekart.** (Phys. Rev. 25. pp. 139–146, Feb., 1925.)—It is well established that arcs may be maintained in gases or vapours at voltages as low as their ionising potentials, or, in cases where cumulative ionisation is possible, as low as their radiating potentials, provided a hot kathode is used as a source of electrons. Considerable discussion has been occasioned by arcs which have been maintained at still lower voltages, since at such voltages the electrons are known not to effect either partial or complete ionisation of the molecules with which they collide. Recently Bär, v. Laue and Meyer, and, independently, the present writer [see Abstract 192 (1925)] have shown that some of these arcs, notably those in helium, may be accounted for by the existence of electrical oscillations, the peak voltages of which always exceed the lowest radiating potential of the gas. Experiments with a tube provided with an anode and a hot filament kathode, built and used with elaborate precautions for excluding mercury-vapour, disprove the suggestion that traces of mercury-vapour as an impurity play an essential rôle in permitting arcs in helium to operate at abnormally low voltages. An arc tube, provided with a movable exploring electrode which is used according to Langmuir's method, enables measurements of potential, of ion concentration, and of average energy to be made in all parts of the arc. With arcs operating on about 6 volts, the *kathode drop* is invariably very near to 11·5 volts (the minimum radiating potential of argon), so that there is a *reverse field* of about 5 volts existing throughout the greater part of the arc. The fact that the arc current of almost an ampere flows against this field is due to the effect of diffusion arising from the large concentration gradient. The *electron concentration* varies from the order of $10^{12}$ per c.c. just outside the kathode to about $10^{10}$ near the anode. The reverse field is due to the difference between the mobilities of electrons and of positive ions, and is therefore most pronounced in the case of argon, in which electron-free paths are abnormally long. The most interesting single feature of this research is the proof of the importance of ion diffusion in low-voltage arcs. [See Abstract 2828 (1924).] A. E. G.

**1458.** *Determination of Elementary Charge E from Measurements of Shot-Effect.* **A. W. Hull** and **N. H. Williams.** (Phys. Rev. 25. pp. 147–173, Feb., 1925.)—The measurements of probability fluctuations in thermionic emission (shot-effect) here described are mostly made at a single frequency (725 kilocycles). A few scattered measurements have been made over the narrow range from 600 to 1000 kilocycles, with exactly similar results. No evidence is found of any dependence of the shot-effect upon frequency, except that involving the constants of the tuned circuit. It is believed that the divergent results obtained by Hartmann are satisfactorily accounted for by the faulty method used for measuring mean-square shot-voltage, as pointed out by Fürth. The accuracy of measurement of E by means of the shot-effect is limited only by the degree to which residual space-charge effects can be avoided. Photoelectric current (10 micro-amperes is sufficient) offers advantages in this respect, on account of the high initial velocities. All other errors in the measurements are purely instrumental and can be reduced without limit. Chief among them is deviation from a true "voltage square" law of detection, for upon this law a faithful record of the mean square of the irregular shot-voltage depends. A lower frequency than that used in these tests recommends itself for ease of manipulation. With too low a frequency, however, difficulty is to be anticipated in finding a detecting instrument with sufficiently long period to record accurately the *mean* of the varying shot-disturbance. A. E. G.

**1459.** *Temperature Relationship of the Kathode Spot of an Arc Light.* **H. Stolt.** (Zeits. f. Physik, 31. 1–4. pp. 240–252, 1925.)—The objections raised by Günther-Schulze [see Abstract 191 (1925)] on the results obtained in a previous communication by the author are here criticised. It is claimed that recent experiments with rotating arcs as well as the estimations of the temperature of the kathode spot by Langbeins seem to support the author's views. The presence of cathodic metallic vapours in the layer lying next the kathode appears to be a necessary condition for the arc discharge. It also seems possible for a photoelectric generation of electrons at the kathode of the arc light to take place without a necessarily high temperature. A. E. G.

**1460.** *Theory of the Schrott-Effect.* **T. C. Fry.** (Frank. Inst., J. 199. pp. 203–220, Feb., 1925.)—The space current in a vacuum tube is not the steady flow of a continuous fluid. It is a migration of discrete particles which possess regularity only in a statistical sense. Either the discrete nature of the particles or the inequality in the time intervals between them would be sufficient to affect any receiving circuit that could distinguish between steady and variable currents. The magnitude of the effect might conceivably be very small, but if it were sufficiently amplified by a perfect amplifier, it could be made to actuate a telephone receiver. It would then manifest itself as an audible noise. If some other fluctuation, such as an attenuated telephone message, were superposed on the original space current, it would be amplified to exactly the same degree as the statistical fluctuations and would likewise result in an audible signal. The intelligibility of the message would then depend upon the ratio of the signal amplitude to the amplitude of the statistical variations. If this ratio were too small, the noise would mask the signal and the result would be worthless for communication purposes. In other words, even with perfect amplifiers, there is a lower limit of intensity below which electrical signals cannot be detected by vacuum tubes, because of the lumpiness of the space current in the first tube. The present paper contributes nothing to the subject of amplification, but it does apply to any type of measuring circuit, which the earlier papers did not. In addition the hypotheses upon which the argument rests are stated explicitly and in physical terms, and the whole discussion is attached to a skeleton of physical intuition, in order that it may not be too difficult to determine how these hypotheses should be reconstructed to eliminate discrepancies between theory and experiment. The paper consists of three parts. The first is devoted to the "frequency spectrum of the electron stream" and reaches the conclusion that no such frequency spectrum exists. The second presents a different mathematical approach to the subject and explains the physical hypotheses upon which it is based. The third contains several theorems which materially simplify the labour of computation. A. E. G.

**1461.** *Thermal Ionisation.* **M. N. Saha** and **N. K. Sur.** (Indian Chem. Soc., J. 1. pp. 9–18, Sept., 1924.)—Theory relative to the thermal ionisation of gases has previously been given by one of the authors [Abstract 1398 (1921)]. The present paper gives preliminary results obtained in experiments made to test this theory. A special furnace was used, consisting of a small furnace within a larger one, both being evacuated. The substance under investigation was introduced into the smaller furnace, which was heated to the required temperature, and the substance in vapour form was then let into the larger furnace maintained at a higher temperature. This arrangement allowed the concentration and temperature to be varied at will. Experiments with Hg, Cd and Zn proved that the vapours of these elements are not ionised at all by heat up to 1250° C. This is to be expected, since the ionisation potentials are rather high. Experiments with Mg vapour indicated ionisation at about 1300° C., and Ca and Na vapours appear to be appreciably ionised at 1100° C. and 900° C. respectively. A. W.

**1462.** *Characteristic of Currents in Slightly Ionised Gases.* **E. Schweidler.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 1–2. pp. 23–27, 1924.)—In this paper, which is of a theoretical nature, the following points are briefly discussed: The J. J. Thomson approximation formula for the current-tension characteristic in an ionised gas, the linear re-union equation, the characteristic with linear re-union. [See next Abstract.] A. E. G.

**1463.** *Experiments on Characteristic of Currents in Slightly Ionised Gases.* **W. Schlenck.** (Akad. Wiss. Wien, Ber. 133. 2a. No. 1–2. pp. 29–33, 1924.)—A cylindrical condenser is used as ionisation vessel, and by means of a quadrant electrometer current-tension curves are obtained. It is found that the form of the characteristic corresponds with the linear re-union. The observations enable a simple determination of the oscillation constant $\beta'$ to be made. The results found are in good accord with those of E. Schweidler. It is found that the oscillation constant depends upon the number of adsorption grains present. [See preceding Abstract.] A. E. G.

**1464.** *Quasi-neutral Electric Diffusion in Gas, at Rest or Flowing.* **W. Schottky** and **J. v. Issendorff.** (Zeits. f. Physik, 31. 1–4. pp. 163–201, 1925.)—Experiments on the influence of a stream of vapour on the ion and electron currents in a Hg-vapour discharge. A theory of electric diffusion in quasi-neutral stationary and flowing gases, developed for the case of positive and negative unipolar and also for ambipolar diffusion and applied to some important problems, including the wall-current in large rectifiers and the determination of the ambipolar-diffusion constant in the mercury discharge, which is found at 100 $\mu$ pressure to be of the order 3000 cm.$^3$/sec. A. D.

**1465.** *Contemporary Advances in Physics. Electricity in Gases.* **K. K. Darrow.** (Bell System Techn. J. 4. pp. 112–151, Jan., 1925.)—After a short introduction the subject is dealt with under the following heads: The flow of electrons through a very rarefied monatomic gas and their encounters with the atoms; the flow of electrons across dense air, nitrogen, hydrogen and similar gases; the discharge begins to contribute to the electron-stream which maintains it; some space-charge equations; the self-maintaining discharges. A. E. G.

**1466.** *A Critical Potential of Methane and its Absorption in the Ultra-violet.* **G. Glockler.** (Nat. Acad. Sci., Proc. 11. pp. 74–77, Jan., 1925.)—In a previous paper [see Abstract 1871 (1924)] it was stated that the maximum in the current potential curve found in a *three*-electrode with methane must be due either to a resonance potential of methane or to a large transparency for slow electrons. Experimental work described with details in the present paper, however, shows that no part of the maximum obtained in three- or four-electrode tubes filled with methane can be due to a resonance potential. The work does not eliminate, however, the possibility of a non-radiating critical potential occurring at the voltage in question. The experiments consist in the measurement of the absorption of methane for ultra-violet light and in the study of Lenard photoelectric curves in methane. The current potential curves obtained by the resonance method are also included. The results of the whole of the experimental work indicate that a maximum in the current may be due to: (1) A true resonance potential of the gas; (2) a possible critical potential; (3) variable mean-free path of the electron; (4) dissociation of the molecule; (5) thermal decomposition by the hot filament. In particular it is pointed out that critical potentials obtained by the resonance method are not easily interpreted for a substance for which no spectroscopic data exist. H. H. Ho.

**1467.** *Heat of Evaporation of Electrons.* **J. J. Weigle.** (Phys. Rev. 25. pp. 187–192, Feb., 1925.)—On the assumption that the electrons form a space lattice like negative ions, the following expression for the heat of evaporation of electrons $L_0$ is derived, in terms of the grating energies $V_R$ and $V_{RX}$ of the metal itself and of a salt RX of this metal, and of the radii $r_p$ and $r_n$ of the positive and negative ions forming the crystal

$$L_0 = V_R - V_{RX} r_n/(r_n + r_p) + a$$

where $a$ is the energy necessary to transform the positive lattice of the metal into that of the salt. The values calculated for the alkali metals by this formula, taking $a = 0$ and computing the radii from the heat of hydration of the salt, are: For Na, 1·83 (1·82); K, 1·53 (1·55); Rb, 1·54 (1·45); Cs, 1·34 (1·36), each in volts per electron. The observed values are given in parenthesis. The values of $V_R$ and $V_{RX}$

are not actually known with sufficient accuracy to allow an exact calculation of $L_0$, but the values given above seem to support the hypothesis that the electrons in metals form a space lattice just as the negative ions in ordinary salts do. [See Abstract 1879 (1924).] AUTHOR.

**1468.** *Thermal Theory of Gas Ignition by Electric Sparks.* **J. D. Morgan.** (Phil. Mag. 49. pp. 323–336, Feb., 1925.)—The main purpose of this paper is to examine the thermal theory of gas ignition by electric sparks in the light of experimental results. The theory asserts that ignition depends on the raising of a sufficient volume of the combustible gas to a sufficient temperature. It follows from a mathematical development of the theory that the energy required for ignition of a given gas varies with (*a*) the rate at which heat is imparted to the gas, and (*b*) the shape and proximity of the electrodes. The chief points may be summarised by stating the following experimental results, which agree with the thermal theory of spark ignition: (1) The incendivity of capacity sparks is found in general to be greater than that of inductance sparks, in accordance with the theoretical result that a source of short duration is more effective than one in which the heat is supplied over a longer interval. (2) The incendivity of capacity sparks depends upon the shape and relative position of the spark electrodes in a manner to be expected on the thermal theory. (3) The energy required for ignition of a given gas by low-voltage inductance sparks is constant over a wide range of values of self-inductance and current so long as the duration of the spark is constant. (4) There is no difference in the incendivity of inductance sparks produced in direct and alternating current circuits. (5) Experiments on the ignition of highly inflammable solids by means of very short hot wires show that the energy required for ignition increases with diminution of the rate of heating, and that over a wide range a linear relation exists between the energy and the time during which it is supplied. It is also shown that other important variations found in experiments are attributable to the manner in which the spark energy is measured. A. E. G.

**1469.** *Gas-Ion Mobilities.* **L. B. Loeb.** (Phil. Mag. 49. pp. 517–519, Feb., 1925.)—A correction has to be applied to the equation derived by the author for gas-ion mobilities in a previous paper [Abstract 2832 (1924)] due to the omission of the factor $\sqrt{2}$ from the denominator of Langevin's factor $\lambda$. Thus the ionic mobility equation and the computed values previously given must all be multiplied by the factor $\sqrt{2}$. A corrected table is appended. The author also notes his discovery of a paper by Langevin in the *Annales de Chimie et de Physique*, VIII. 5. p. 238, 1905, giving a vigorous derivation of the Langevin equation. This leads to the same final equation as the author's except for a constant, and thus confirms the validity of the present work. S. G. B.

**1470.** *Spark Constants and Waves on Wires.* **M. Toepler.** (Archiv f. Elektrot. 14. pp. 305–318, Feb. 3, 1925.)—A theoretical and experimental investigation of the laws governing spark discharges with capacity in circuit and applications of the theory to waves along short and long antennæ. Tables are given of the spark constants for discharge between spheres of various diameters and for different air-pressures. [See Abstract 953 (1906).] A. W.

**1471.** *Short Electric Waves obtained by Secondary Emission in Triodes.* **E. W. B. Gill** and **J. H. Morrell.** (Phil. Mag. 49. pp. 369–379, Feb., 1925.)—The authors here continue their investigations into the oscillations which occur in hard values when a Lecher wire system is connected to the grid and anode [see Abstracts 2444 (1922) and 2243 (1923)]. But in the experiments here described the grid has still the highest positive potential, but the plate, instead of being at the same potential as the filament, is also at a fairly high positive potential. The electrons passing through the grid reach the plate whether or no oscillations are occurring, and so the secondary emission from the plate becomes important. The results of a large number of experiments are given, and a simple theory is formulated which is in accordance therewith in so far that the general experimental results that all wave-lengths above a certain value, and a range of shorter wave-lengths, can be maintained. But the agreement is not good when numerical comparisons are made. However, the theory cannot be expected to account for more than the main features of the experiments. G. W. DE T.

**1472.** *Measurement of Amplification.* **W. Wolff.** (Zeits. techn. Physik, 6. 1. pp. 35–38, 1925.)—A discussion of the method of measuring amplification by aural comparison with a source of variable and calculable intensity. The conditions under which the method may be safely employed are given. A. W.

**1473.** *Systems which Behave Differently with Atmospheric Disturbances and with Radio Vibrations.* **G. Stetter.** (Phys. Zeits. 26. pp. 187–188, Feb. 1, 1925.)—Refers to J. Zenneck's recent paper on the above subject [Abstract 414 (1925)]. The author used a device in 1917, during the war, in which the antenna was connected to one end of the usual receiving coil, the other end being connected to one pole of a condenser, the second pole of which was earthed; the resistance of the coil was small, and the inductive resistance was zero in the case of resonance. From the junction between the antenna and the coil a branch circuit leads to earth through a coil, the self-induction of which need not be large, but which can be regulated to a certain extent so as to avoid resonance. The ohmic resistance of this coil for high frequencies can be increased by means of skin action by using tinned copper wire; the action can be increased by introducing an iron core; high-frequency vibrations pass mainly through the receiver coil; atmospherics, such as slow discharges due to static charges of the antenna, will pass through the branch resistance to earth. The chief difficulty is that atmospherics are really complicated phenomena, and differ greatly among themselves. H. N. A.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

**1474.** *An Experimental Study of the Electrical Conductivity of Disperse Systems. I. Cream.* **H. Fricke** and **S. Morse.** (Phys. Rev. 25. pp. 361–367, March, 1925.)—The well-known formula for the conductivity of a suspension of non-conducting spheres is $(k_1 - k)/(2k_1 + k) = \frac{1}{2}p$, where $k$ and $k_1$ are the specified conductivities of the suspension and of the suspending medium and $\rho$ is the volume concentration of the disperse phase. This formula was experimentally verified within about 0·5 % for values of $\rho$ up to 62 %, by comparing the values of $\rho$ given by the formula with the values obtained directly from the known dilutions. Since the conductivity was found to change with the age, due to incipient souring, measurements were made quickly. Stirring was used instead of shaking to avoid introducing finely divided air, and was effected by using a special cell in which a bead rolled back and forth as the cell was rocked. After stirring was stopped there was a rapid increase of resistance, due, perhaps, to the particles taking up an ordered arrangement. The temperature coefficient was found to be the same for the cream as for the skimmed milk, decreasing from 2·65 % at 6° to 2·12 % at 25° C. The variation with frequency was a 2 % decrease of conductivity as frequency was increased from 1600 to 200,000. These results indicate that the measurement of conductivity furnishes a practical method of determining the butter fat in milk and cream, which is as accurate as those now used. AUTHORS.

**1475.** *Electrical Conductivity of Metallic Aggregates.* **I. Runge.** (Zeits. techn. Physik, 6. 2. pp. 61–68, 1925.)—This mathematical paper develops a new view and extension of Rayleigh's work on the potential of conductors placed together in special arrangements. Applications of the results are made to the conductivities of binary alloys. E. H. B.

**1476.** *Investigation of "Silit" Resistances at High Frequencies.* **E. Alberti** and **A. Günther-Schulze.** (Zeits. techn. Physik, 6. 1. pp. 11–18, Jan., 1925. From the Reichsanstalt.)—An investigation was made of the properties of resistances of the type called "Silit," made by Siemens Bros., and of similar resistances called "Ozelit," made by Conradty & Co. These resistances, in the form of short straight rods, range from a few ohms to very high values, and are practically free from inductance or capacity. The value of the resistance for direct current depends very largely on the applied potential. With high potentials the resistance may be less than 1 % of the value for low potentials. Some specimens tested, however, showed little variation of resistance with the applied potential. At the temperature of liquid air the resistances were on the average about three times greater than at ordinary temperatures. With high-frequency oscillations up to 1400 m. wave-length there is a similar dependence of resistance on applied potential to that found with direct current, so that it is possible to use "Silit" resistances with a positive or negative potential as detectors. At high frequencies the self-capacity of "Silit" rods of the usual dimensions (length 43 mm., diameter 6 mm.) is of the order of 10 to 20 c.m. A. W.

**1477.** *Dielectric Constants of Liquids.* **L. A. Sayce** and **H. V. A. Briscoe.** (Chem. Soc., J. 127. pp. 315–322, Feb., 1925.)—A method of determining the dielectric constants of liquids by using a triode connected with a condenser in which either a vacuum, air, or the substance under investigation may be used as dielectric is described, and a variable condenser having a range of 500 $\mu\mu$F., and capable of being set and read with an error not exceeding 0·005 $\mu\mu$F., was employed, together with two other condensers and a potentiometer with regulating resistances, are used. The various capacities of the condensers in the circuit were intercalibrated. It was found that the method was very sensitive to changes of temperature and to the influence of sunlight, so that the measurements had to be made in artificial light. In order to test the accuracy of the method, the dielectric constant of benzene at 25·5° C. was determined. The results gave 2·2389 as a mean of four determinations, and the mean difference from the mean was ± 0·0005. F. J. B.

**1478.** *Dielectric Constant and Absorption Coefficient of Glycerine.* **R. Bock.** (Zeits. f. Physik, 31. 7–8. pp. 534–543, 1925.)—The production of short electrical waves by means of electron tubes made it possible to modify Drude's method for determining dielectric constants [see Abstract 908 (1920)]. The dielectric constant and absorption coefficient and their dependence upon temperature were investigated. It was found that from − 140° C. to about − 15° C. the dielectric constant is practically constant at 3·0. From − 15° C. and + 60° C. it increases from 3 to 36, and then slowly decreases. The absorption coefficient has a maximum at 22° C. The Debye theory is discussed in the light of the older work and the above results. F. J. B.

**1479.** *On the Dielectric Constant of Water in Strong Electrolytes.* **H. Zahn.** (Zeits. f. Physik, 31. 5–6. pp. 362–372, 1925.)—A short review of previous work is first given [see Abstracts 2328 and 2541 (1923)]. The problem as to whether the dielectric constant of a concentrated electrolyte solution is appreciably altered with respect to that of the solvent has been investigated on saturated lithium chloride solution, which appears particularly suitable for the purpose. The method employed is that of the intensity change of a radiation field by a dielectric cylinder as worked out theoretically and experimentally by Schaefer and his collaborators for insulators. To eliminate the influence of conductivity the field change due to a cylinder of lithium chloride solution was compared with that produced by a much more dilute solution of sodium chloride of the same conductivity. The dielectric constant of the lithium chloride was found to be lower than that of the comparison solution. While the numerical value has not yet been accurately ascertained, it is certainly less than 57 and probably less than 42. H. H. Ho.

**1480.** *The Electrode Potential of Mercury against its Ions in Aqueous* (1) *Methyl Alcohol,* (2) *Acetone, and* (3) *Pyridine.* **J. Ghosh, P. R. Chaudhuri** and **A. Sen.** (Indian Chem. Soc., J. 1. pp. 189–200, Dec. 31, 1924.)—Measurements are made of the absolute potential of mercury in different solutions containing its ions by determining the maximum position of the electrocapillary curve. From the Lippman-Helmholtz original equations the following relation is derived: $\gamma = \gamma_{(\text{max.})} - \frac{1}{2}CE^2$ where $\gamma$ is the surface tension of mercury, C the capacity of unit area of the double layer, and E the p.d. at the boundary. Measurements are made with a U-tube capillary electrometer, to which definite potentials are applied, and the mercury meniscus is read with a microscope. The residual currents corresponding to definite polarisation voltages are investigated. The tendency of the electrolyte to creep between the glass wall and the mercury column, thus causing a variation of the capacity of the double layer, is checked as far as possible. A considerable influence on electrocapillary effects appears to be exerted by the adsorption of ions by the mercury surface. With an aqueous solution of nitric acid and mercurous nitrate a fairly good parabolic curve, as demanded by the equation, is obtained with a maximum at

1·05 volts. This determination agrees with the value of 0·391 found for the e.m.f. of mercury in this electrolyte against a calomel electrode of which the single p.d. is taken as 0·612. Measurements are made in aqueous mixtures of methyl alcohol, acetone and pyridine, and a determination is made of the dielectric constants, D. The potentials E fall with diminishing content of water. With methyl alcohol and water mixtures containing over 50 % of the latter an approximate constant value of about 0·93 is obtained for E/D. In aqueous acetone an abnormally low value of the potential is given with a 20 % acetone mixture, but with this exception the ratio E/D remains constant at about 1·25 up to 40 % acetone and thereafter increases. With pyridine-water the ratio E/D is practically constant at about 0·75 within the range 10 to 40 % of pyridine. Within a certain range the free energy of the mercurous ion is in the proportional to the dielectric constant. [See Abstract 1875 (1913).] J. N. P.

**1481.** *Photoelectric Conduction in Na-Cl Crystals.* **Z. Gyulai.** (Zeits. f. Physik, 31. 1–4. pp. 296–304, 1925.)—This paper deals with (1) the spectral distribution of the photoelectric sensitiveness of rock-salt crystals under the incidence of X-rays, and (2) the changes in this spectral distribution by subjection to the incidence of short waves. In the first part it is found that the maximum photoelectric effects occur for X-rays of $\lambda = 0 \cdot 4\, m\mu$. A number of graphs are included in the paper. E. H. B.

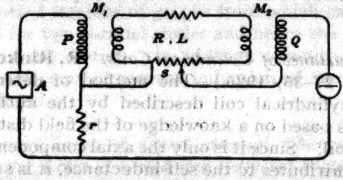
**1482.** *Significance of Gas Contents of Metals for some Electric Phenomena.* **A. Janitzky.** (Zeits. f. Physik, 31. 1–4. pp. 277–295, 1925.)—The electric current through a high-vacuum tube with incandescent kathode is dependent on the gas content of the anode; the current ceases if the anode is severely deprived of gas. The contact of two electrodes of the same metal, one slightly and one strongly "degassed," calls forth a current from the former to the latter. A wire degassed by incandescence in a high vacuum shows an increase of resistance, which disappears on its taking up gas again—a proof that the gas occluded in the metal takes part in the conduction. On the basis of these phenomena the assumption is made that the gas occluded in a metal is dissociated. E. H. B.

**1483.** *A Simple Apparatus for Obtaining Comparative Measurements of the Resistances of Medium Insulators.* **A. J. Philpot.** (Journ. Sci. Instruments, 2. pp. 166–168, Feb., 1925.)—A method is described of obtaining a comparative measure of the resistances of medium insulators by comparing them with the resistance of an agate standard. A known potential difference is applied to the ends of the unknown resistance and the agate standard in series. The potential drop across the unknown resistance is measured by means of an electroscope and hence its resistance is obtained in terms of that of the agate standard. AUTHOR.

**1484.** *On Methods of Varying the Sensitiveness of Ballistic Galvanometers.* **M. Masius.** (Phys. Rev. 25. pp. 211–217, Feb., 1925.)—When a condenser is discharged through a ballistic galvanometer and then the same discharge is used with the same galvanometer when shunted, the ratio of the throws depends partly on the reduced charge going through the galvanometer and partly on the damping produced by the shunt. General formulas for this ratio have been obtained in terms of a galvanometer constant $m_0$ and the ratio $n$ of the shunt resistance to that of the galvanometer. If it is desired to reduce a given throw to either one-fifth or one-tenth of the original value, the shunt resistance required for this purpose may be obtained from a table, which is given, provided the resistance of the galvanometer is known, and also the shunt resistance required to reduce a given throw to one-half, which is readily found by trial. [See also Abstract 2148 (1924).] AUTHOR.

**1485.** *A Valve Ohmmeter.* **S. Loewe** and **W. Kunze.** (Zeits f. Hochfrequenztechn. 25. 3. pp. 67–70, 1925.)—A three-electrode valve is used with an anode battery and milliammeter connected between anode and filament. The resistance to be measured is connected between anode and grid, and definite values for grid voltage and grid current are obtained. These values depend on the resistance, and thus the resistance can be measured. A wide range of values of resistance can be measured from zero to very large values of the order of 1000 megohms. Voltage, capacity and current can also be measured. J. R.

**1486.** *Direct-Reading Frequency Meter of Long Range.* **A. Campbell.** (Phys. Soc., Proc. 37. pp. 97–98; Disc., 98–100, Feb., 1925.)—A new frequency meter is described, reading by single adjustment, and embodying a new method of balancing mutual inductance by resistance. Two mutual inductances $M_1$ and $M_2$ are connected with an alternating source A and a detector (*e.g.* a vibration galvanometer) as shown, their secondary circuits, with added resistance, forming a loop having total self-inductance L and resistance R, of which a portion $s$ is tapped off into the detector circuit; $r$ is a non-inductive resistance.



When G shows no current, $\omega^2M_1M_2 = Rr$, and $M_1s = Lr$. If $M_1$, $r$ and L are fixed, $s$ can be set once for all to satisfy the second condition and the frequency $n$ $(= \omega/2\pi)$ is then equal to $a/\sqrt{M_2}$, where $a$ is a constant. If $r$ and $M_1$ are invariable, by changing R various values of the scale multiplier $a$ may be obtained. In the actual instrument the scale of $M_2$ is marked to read $n$ directly for a given value of R, and a number of other ranges are obtained by altering R in suitable proportions. The total range covered is from about 180 to 4000 cycles per sec., and other ranges extending from 18 to 400 cycles can easily be added. The accuracy is within 1 in 1000 at all points. A. W.

**1487.** *Electrometer Measurement of Extremely Small Electric Currents.* **B. Szilard.** (Comptes Rendus, 180. pp. 576–578, Feb. 23, 1925.)—The instrument used is an electrometer of quite a novel type which will detect a current of the order of $10^{-5}$ electrostatic units and will measure, with errors of this order only, currents $10^5$ times as great. The electrometer consists of an air condenser, the interior plate of which is single, while the exterior plate is divided into two parts *a* and *b* insulated one from the other; *b* is connected to one pole of a battery, while *a* is earthed. If now the air in the associated condensers be rendered conducting by means of an ionizing radiation, then, as soon as equilibrium is obtained, the potential of the divided plate will become constant, its value depending on the ratio of the quantities of electricity which have traversed *a* and *b* respectively. If these be equal, the interior plate will attain a *critical* electric state characterised, provided the current remains less than that of saturation, by its potential becoming independent of the potential applied to the exterior plate, independent also of the intensities of radiation acting simultaneously on the two dielectrics and finally, independent of the time taken. To compare the quantities of electricity which have traversed *a* and *b* the radiation from metallic radiolead is employed, supplying a current proportional to its surface. The latter is easily adjusted by mechanical means. Since the *critical* state appears sharply, currents much smaller than would be detected by ordinary electrometric observation can be detected and measured. G. W. DE T.

## ALTERNATING CURRENTS AND MAGNETISM.

**1488.** *Two-Dimensional and Axially Symmetrical Fields.* **P. Andronescu.** (Archiv f. Elektrot. 14. pp. 379–396, Feb. 20, 1925.) —A purely analytical treatment of these two problems, with numerical examples. A. H.

**1489.** *Self-inductance of Cylindrical Coils.* **R. Rinkel.** (Zeits. techn. Physik, 6. 1. pp. 27–35, 1925.)—The method of determining the self-inductance of a cylindrical coil described by the author consists of a summation process based on a knowledge of the field distribution due to a single turn of the coil. Since it is only the axial component of the magnetic intensity which contributes to the self-inductance, it is sufficient to determine this component only. The determination was carried out experimentally for a wire 4 mm. thick bent into a circle of 1 m. diam., a tangent galvanometer being employed to determine the relative field strength at various distances from the plane of the circle and from its axis. An accurately measured current was sent through the galvanometer coil, and was so adjusted as to give a deflection of 45° in each case. The field strength was determined for 200 points, and the results are given in the form of tables and graphs. From these, by the process of summation referred to above, data are obtained by means of which the self-inductances of coils of any number of turns and layers may be calculated, up to a limit of 2·6 for the ratio of length to diameter of coil. A. H.

**1490.** *Rectification of Alternating Current by Means of the Hall-Effect.* **R. Sarek.** (Elek. u. Maschinenbau, 43. pp. 172–175, March 8, 1925.)—If a metallic plate be placed in a magnetic field, so that the flux is directed through the thickness of the plate, and a current is passed along the length, a voltage can be measured across the width of the plate. If the flux and current are alternating and in phase, the resulting voltage is continuous and pulsating. Bismuth gives the best results, but even with several plates in series, practical values of voltage cannot be obtained. The author points out that if an alternating pressure is placed in series with the transverse voltage, the apparatus acts as a rectifier. It is suggested that the principle could be used to produce direct current without a commutator, and also that the apparatus could replace crystal detectors in wireless work. R. G. J.

**1491.** *Determination of the Coefficient of Mutual Induction of Two Coaxial Coils.* **J. Hak.** (Rev. Gén. d'Él. 17. pp. 329–335, Feb. 28, 1925.)—In all cases the coefficient of mutual induction M of two parallel and co-axial circles may be expressed by means of elliptic functions in the form :—

$$M = 2\pi\sqrt{Dd}\left\{\left(c - \frac{2}{c}\right)F(c) + \frac{2}{c}E(c)\right\}$$

where D and $d$ are the diameters of the circles, and $x$ the distance between their planes, and F $(c)$ and E $(c)$ are the complete elliptic functions of the modulus

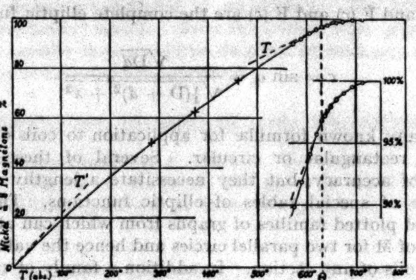
$$c = \sin \alpha = \frac{\sqrt{Dd}}{\sqrt{\frac{1}{4}(D + d)^2 + x^2}}$$

There are many known formulæ for application to coils of a particular section, *e.g.* rectangular or circular. Several of these give M to a high degree of accuracy, but they necessitate a lengthy calculation or even the use of special tables of elliptic functions. The author has calculated and plotted families of graphs from which can at once be read off the value of M for two parallel circles and hence the value deduced for two coaxial coils of any section. In addition a family of curves is given from which the coefficient of mutual induction of similar two flat coils can readily be deduced. A. E. C.

**1492.** *Preliminary Lines of Equal Annual Change of the Magnetic Elements in* 1915 *for Latin America and Adjacent Waters.* **H. W. Fisk.** (Terrest. Magn. 29. pp. 139–148, Dec., 1924.)—Magnetic observations have been made every year since 1905 by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in some part of the area indicated. The project of reoccupying selected stations distributed with fair regularity over the entire land area of the Western Hemisphere south of 33° N. lat. will be complete in 1925, and before undertaking a mathematical discussion of the material it was thought advisable to determine the general character of the lines of equal annual change of the three elements, declination, inclination, and horizontal intensity, by a general review of the data and the construction by simple graphical processes of preliminary charts showing the lines for some suitable epoch. Such charts have been prepared, and are reproduced with the paper. For detailed results the original publication should be consulted.

W. V. M.

**1493.** *Equation of Magnetic State and Variation of Atomic Moment.* **P. Weiss.** (Comptes Rendus, 180. pp. 358–361, Feb. 2, 1925.)—The equation of magnetic state, or relation between the specific magnetization $\sigma$, the field H and the temperature T, of a ferromagnetic substance is obtained from that of a paramagnetic substance by the addition to H of a molecular field $H_m$. The author adopts for the former Langevin's relation based on statistical mechanics, and has hitherto assumed that $H_m = n\sigma$, where $n$ is a constant. The equation so obtained explains many facts otherwise unaccounted for. There remained, however, some systematic divergences of theory from experimental facts dealt with in a recent paper by himself and R. Forrer [Abstract 2602 (1924)], which showed that the theory requires modification. Careful scrutiny led to the adoption of the variability, in place of the invariability, of the atomic moment as a fundamental hypothesis. Invariability could at most be statistical only. In the former experiments there were always present atoms of nickel containing, respectively, three and eight magnetons in varying proportions. The experimental method suggested was (1) to plot the percentage of nickel containing eight magnetons per atom against the absolute temperature, as in the accompanying diagram; (2) assuming the correctness of the theory founded on statistical mechanics and the molecular field for all percentages, to subvalues of this percentage for which the calculated values of $\sigma$ agree with the experimental values for a stretch of values of H and T. The criterion of the truth of the modified theory will be the coherence of these stretches into a continuous curve. It will be seen that the continuity of the curve is excellent. G. W. DE T.



**1494.** *Direction Quantisation in a Magnetic Field.* **W. Gerlach.** (Ann. d. Physik, 76. 2–3. pp. 163–197, Jan., 1925.)—A previous investigation into the effect of a magnetic field on normal silver atoms [Abstracts 2055 (1922) and 2662 (1924)] is extended to other metals. The atoms are emitted from a small furnace, and a small parallel beam is formed by means of slits in two screens. This beam is led through a non-homogeneous magnetic field produced, at right angles to the path of the atoms, between a long wedge-shaped pole-piece whose edge is parallel to a long slotted pole-piece. The atoms impinge on a plate beyond the electromagnet, and the whole apparatus is enclosed in an evacuated vessel. The heating is done by a.c. through molybdenum wire round the furnace. The image of the slit on the receiving plate becomes loop-shaped under the action of the magnetic field; the separation of the limbs of the loop is employed in calculating the atomic moment of the metal concerned. The value for silver is 5690 gauss-cm. Of the metals tested, copper, silver and gold exhibit the separation into two rays; monatomic structure and equal magnetic moment are indicated. Lead, tin and iron atoms are unaffected by the magnetic field, and the greatest magnetic effect was obtained in the case of nickel. G. E. A.

**1495.** *Proposed Test of the Space Quantisation of Atoms.* **A. E. Ruark** and **G. Breit.** (Phil. Mag. 49. pp. 504–508, Feb., 1925.)—Commenting on the experiment of Gerlach and Stern [see Abstracts 2662 and 2663 (1924)], if all atoms, say, of helium, should be orientated with their axes of angular momentum perpendicular to the direction of a magnetic field, helium should have different dielectric constants when an electric field is applied parallel or perpendicular to the magnetic field. This possibility is discussed. G. E. A.

**1496.** *Magnetic Constraint in Deformable Bodies having a Non-Rectilinear. Characteristic of Magnetisation.* **T. Lehmann.** (Rev. Gén. d'Él. 17. pp. 515–519, April 4, 1925.)—In continuation of previous work [see Abstract 1213 (1925)] the author applies Kelvin's theorem to the determination of the magnetic constraint in a deformable body placed in a saturated or unsaturated field, and shows that in isotropic solids certain formula deduced by Cohn [Das elektromagnetische Feld, 1900, p. 517] are valid provided the magnetic characteristic, and more especially the surface enclosed between the characteristic and the axis of ordinates, is not affected by the deformation. If, however, the characteristic be a function of the specific volume of the medium, then an additional term, as suggested by Liénard, enters into the analysis of the constraint. In the general case in which the magnetic characteristic varies differently in directions respectively parallel and transverse to the magnetic field, different additive terms enter into the expressions for the magnetic pressures and tensions. J. S. G. T.

**1497.** *A Contribution to the Theory of Ferromagnetism.* **E. Ising.** (Zeits. f. Physik, 31. 1–4. pp. 253–258, 1925.)—An attempt to modify Weiss' theory of ferromagnetism by consideration of the thermal behaviour of a linear distribution of elementary magnets which (in opposition to Weiss) have no molecular field but only a non-magnetic action between neighbouring elements. It is shown that such a model possesses no ferromagnetic properties, a conclusion extending to a three-dimensional model. W. V. M.

## RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

**1498.** *Propagation of Short Waves in Living Tissues.* **L. Chaulard.** (Onde Élec. 4. pp. 53–57, Feb., 1925.)—The use of very short waves, in the form of stationary waves, allows a certain localisation to be obtained of the effects of high-frequency currents in the interior of semi-conductors such as living tissues. The possibility of successful therapeutic use of such waves is foreshadowed by the results obtained by Lakhowsky in treatment of cancerous tumours of zonal pelargoniums. These tumours, comparable to cancer in animals, were produced by inoculation with bacteria. When subjected to repeated applications of waves of very high frequency they were found to die away and finally disappear, the plants becoming perfectly healthy and vigorous again. A. W.

## CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

**1499.** *Sorption of Ammonia and Carbon Dioxide by Glass.* **D. H. Bangham** and **F. P. Burt.** (J. Phys. Chem. 29. pp. 113–129, Feb., 1925.)—The results of measurements of the rate of sorption of ammonia by a glass surface at 0° and at a number of different and approximately constant pressures lead to the relationship $s^m = kp_t\int_0^t p \cdot dt$, where $s$ is the sorption-value at time $t$, $p_t$ the momentary pressure, and $m$ a (nearly) constant number of about 12. This relationship holds for all pressures and times and, except for a temporary derangement, also when the pressure is suddenly increased or diminished during an experiment [Abstract 1590 (1924)]. Experiments with carbon dioxide yielded analogous results, but with this gas the index $m$ varies appreciably with the pressure, to which the sorption-value is far more sensitive. For strictly constant pressures, in the case of ammonia log $s$ would be a nearly linear function of log $(p_t^2)$, whereas with carbon dioxide log $s$ would be a non-linear function of log $(p_t^5)$. T. H. P.

**1500.** *Electro-osmotic Experiments on Intensity of Absorption of a Constituent Ion by an Insoluble Salt. Part I.* **J. N. Mukherjee** and **H. L. Ray.** (Indian Chem. Soc., J. 1. pp. 173–188, Dec. 31, 1924.)—The adsorption of ions by precipitated and carefully washed lead chromate is investigated. Electro-osmotic measurements are made, and by determining the density of the electric charge on the surface it is ascertained whether the adsorbed ions replace those of the same sign in the crystal lattice, thus leaving the crystal surface electrically neutral, or are adsorbed on the surface with or without exchange of ions. Lead chromate is negatively charged in water which may be due either to the adsorption of chromate ions or of hydroxyl ions from the water. The order of adsorbability of kations is $Pb^{\cdot\cdot} > Ba^{\cdot\cdot} > Ca^{\cdot\cdot} > K^{\cdot}$ and that of anions is probably $CrO_4'' > IO_3' > NO_3' > I' > SO_4'' > Cl'$. The constituent ions of a precipitate are very strongly adsorbed by it, lead ions being so strongly adsorbed by lead chromate as to reverse the charge. It is considered probable that besides the lattice energy of the ions, there are other factors such as the energy of hydration of the surface or of the ion which determine the intensity of adsorption or the work necessary to separate an ion from the surface to the interior of the solution. The adsorption of the constituent ions accordingly does not consist simply in the exchange of an ion in the crystal lattice as assumed by Paneth, but also of ions which are actually fixed on the surface imparting a charge to it. The parallelism pointed out by Fajans between the intensity of adsorption of an ion and the solubility of the salt of the adsorbed ion and the ion with opposite sin *g* in the precipitate is not strictly followed, in that the nitrate ion is adsorbed more strongly than the iodide or sulphate. [See Abstracts 91 and 2015 (1923).] J. N. P.

**1501.** *Solubility in Mixtures of Liquids.* **G. Pleuger.** (Phys. Zeits. 26. pp. 167–170, Feb. 1, 1925.)—Measurements have been made of the solubilities of benzamide and *p*-acettoluidide at different temperatures in alcohol-water, alcohol-carbon tetrachloride, and alcohol-carbon disulphide mixtures. At low temperatures addition of water to alcohol increases the solubility of benzamide or *p*-acettoluidide, pronounced maxima appearing; the same occurs with *p*-acettoluidide on addition of carbon disulphide to alcohol. Addition of carbon disulphide or carbon tetrachloride lowers the solubility of benzamide, and addition of carbon tetrachloride that of *p*-acettoluidide, in alcohol. In all these cases, however, the solubilities are greater than those calculated according to the law of mixtures. No connection is traceable between the relation of the dielectric constant of the solvent to that of the added liquid and the alteration of the solubility. At temperatures in the neighbourhood of the melting-point of the substance the solubilities in the mixed solvents agree approximately with the calculated values. T. H. P.

**1502.** *Conductivity Determinations of Very Dilute Solutions.* **H. Remy.** (Zeits. Elektrochem. 31. pp. 88–95, Feb., 1925.)—For the purpose of conductivity determinations, in place of ultra-purified water, ordinary conductivity water may be used provided the only impurity present is carbonic acid, when the correction to be applied can be calculated. In order to determine whether the residual conductivity is due to carbonic acid, a method is developed which consists in adding small known amounts of potassium hydroxide solution. Through elimination of H ions a lowering of the conductivity is thus produced until complete neutralisation is effected in accordance with a relation which is derived from a consideration of the equilibrium constants of the ionic reactions involved. If the amount of carbonic acid so calculated agrees with that estimated by means of the ionic migration velocities from the conductivity of the original water the absence of impurities other than carbonic acid may be inferred. The formulæ evaluating the extent of ionic interactions which are calculated are applied to the determination of the solubility of a number of slightly soluble oxides by allowing for the carbonic acid content of the water. The results obtained agree closely with those given by other methods.
J. N. P.

**1503.** *Velocity of Hydrogen Ions in Gels.* **N. Isgarischew** and **A. Pomeranzewa.** (Zeits. Elektrochem. 31. p. 101, Feb., 1925.)—A criticism of a paper by Liesegang [see Abstract 223 (1925)], and an extension of a previous paper by the above authors. [Abstract 1037 (1924).] F. J. B.

**1504.** *Solid Solutions between Compounds of Elements of Differing Valency.* **G. Bruni** and **G. R. Levi.** (Accad. Lincei, Atti, 33. ii. pp. 377–384, Nov. 16, 1924.)—LiF and $MgF_2$ give solid solutions (X-ray methods as well as thermal). The mixed crystals undergo decomposition at a low temperature as also at a high. It is possible to retain 20 % of $MgF_2$ in LiF at ordinary temperatures; beyond this there is partial separation. The substitution of a certain number of molecules $MgF_2$ for a corresponding number of double molecules $Li_2F_2$ makes no substantial difference in the network. A slight increase in volume accompanies the formation of mixed crystals. A. D.

**1505.** *Numerical Values of Chemical Constants and Frequencies of the Elements.* **A. C. Egerton.** (Phys. Soc., Proc. 37. pp. 75–83; Disc., 83, Feb., 1925.)—The experimental evidence for the general chemical constant $C_0 \left(= \log \frac{2\pi^{3/2} R^{5/2}}{N^4 h^3}\right)$ possessing the theoretical value (− 1·589) is collected. Tables of chemical constants are given and data collected for the determination of characteristic temperatures of the elements. A linear relation between logarithm of mass and characteristic temperature is indicated. A. B. W.

**1506.** *Briquetting and Fritting of Metallic Oxides and Adhesive Forces between Oxide Surfaces.* **F. Sauerwald** and **G. Elsner.** (Zeits. Elektrochem. 31. pp. 15–18, Jan., 1925.)—The results of experiments on triferric tetroxide, ferric oxide, cupric oxide and aluminium [see Abstract 2179 (1924)] show that the tenacity and density of synthetic substances prepared from metallic oxides and from metals the crystallites of which are covered with a layer of oxide, increase with the temperature to which they are heated, except when fissures appear and lower the tenacity. The absolute values of the tenacity are considerably lower than with corresponding materials obtained from pure metals, so that the forces between the surfaces of the crystallites are comparatively small. No signs of crystallisation were observed. T. H. P.

**1507.** *Synthetic Metallic Bodies. IV. Adhesive Forces between Metallic Surfaces.* **F. Sauerwald** and **E. Jänichen.** (Zeits. Elektrochem. 31. pp. 18–24, Jan., 1925.)—The term "fritting" is proposed for solidification processes in which heating leads to conglomerates of crystallites without intervention of the liquid phase, the name "sintering" being applied where the process involves the presence of the liquid phase. Experiments with reduced iron, and with powdered copper and nickel reduced from the oxides have been made, the variation of the tenacity and density of the synthetic bodies with the temperature, pressure, and duration of heating being determined. The results show that the adhesive forces increase with rise of temperature up to the melting-point, the diminution in tenacity and density sometimes observed being occasioned by superposition of crystallisation processes. The manner in which the cooperation of adhesive forces and incipient crystallisation conditions the tenacity attained depends essentially on the relation between the densities before and after the heat treatment. The extent of the contraction depends, not only on the pressure, but also very largely on the macroscopic granularity of the material, so that the latter may influence the variation of tenacity and density with the temperature. Investigation of systems composed of two purely metallic components reveals no fundamentally new factors, the tenacities being of the same order of magnitude as with single metals; hence diffusion plays no primary rôle in these processes. At graphitic surfaces or those of carbides, the adhesive forces are either weak or incapable of taking effect. T. H. P.

**1508.** *Estimation of Gold in Mercury.* **H. Ştammreich.** (Zeits. techn. Physik, 6. 2. pp. 76–78, 1925.)—The method here recommended for obtaining mercury free from gold and for the quantitative determination of the amount of gold originally present is a combination of distillation and chemical separation. The mercury is distilled till only about 1/1000 remains, and the remainder is then treated with pure nitric acid. Good results are obtained in this way. A. W.

**1509.** *Production of Gold from Mercury under the Action of Electric Discharge.* **A. Miethe.** (Zeits. techn. Physik, 6. 2. pp. 74–76, 1925.)—In experiments with mercury arcs it was found that after some time the mercury became impure. Analysis showed that one of the impurities was gold, and the conclusion was reached that it had been produced from the mercury by the action of the discharge. In the present paper the possibility is discussed that the gold found may have been originally present in one of the parts of the mercury lamp, but this does not appear to have been the case. A. W.

**1510.** *Effect of Quenching on the Mechanical Properties after Annealing.* **L. Guillet** and **A. Portevin.** (Rev. de Mét. 22. pp. 52–56, Jan., 1925.)—Seven steels of varying composition were quenched (*a*) in water at 16° C., (*b*) in oil, (*c*) in a boiling saturated solution of sodium chloride in water. Samples from each treatment were annealed in a salt bath at 500°, 575°, and 600°, and the following properties were determined: (1) Hardness after quenching, (2) hardness after annealing, (3) shock strength and angle of bending under shock after annealing, (4) microstructure. *Results.*—The results are given in seven tables, and the authors conclude that for equal hardness after annealing, the shock tests are best on material that has been completely quenched before annealing, that is, which is completely martensitic, and conversely, for equal values for shock tests the more complete the quenching the greater the hardness. J. L H.

**1511.** *The Practical Importance of the Equilibrium Diagram.* **D. Hanson.** (Metallurgist [Suppl. to Engineer], pp. 18–22, Feb. 27, 1925.)—A review of the meaning and practical importance of equilibrium diagrams of alloys. The paper is so condensed as to be unsuitable for abstracting. J. L. H.

**1512.** *Deformation- and Recrystallisation-Structure of Metals.* **R. Glocker.** (Zeits. f. Physik, 31. 5–6. pp. 386–410, 1925.)—A graphic method for the evaluation of rolled structure diagrams. Determinations in silver. A new position assumed by the crystallite on recrystallisation, due to the formation of large new crystals. A. D.

**1513.** *On the Spectro-Photometric Measurement of $P_H$.* **F. Vlès.** (Comptes Rendus, 180. pp. 584–586, Feb. 23, 1925.)—The author has previously used the spectro-photometer for the measurement of $P_H$ by means of indicators, and constructed empirical curves relating the absorption bands of the indicators to the $P_H$ of standard buffer solutions obtained by other methods. Reference is made to similar work by Brode [see Abstract 1617 (1924)] and Holmes. The practical inconvenience of such methods is that the absorption of the indicator is a function of two independent variables, *viz.* $P_H$ and the concentration of the indicator introduced into a given volume of solution, so that it is necessary to construct sets of curves for deviations from the standards. The present investigation seeks for a simple relation between the absorption ratios of the various spectral components of an indicator expressed as a function of $P_H$. Experimental data are included for the normal indicators cresol-red and bromthymol-blue, and for the abnormal crystal-violet. H. H. Ho.

**1514.** *Action of Nitric Acid on Metals.* **N. R. Dhar.** (J. Phys. Chem. 29. pp. 142–159, Feb., 1925.)—The results obtained indicate that there is no fundamental difference in character between the oxidation of metals and that of other substances, such as starch, sugar, etc., by nitric acid. The hypothesis that the action of this acid on metals is electrolytic in nature, and also that of Armstrong and Acworth, who consider that the hydrogen of the acid is first replaced by metals, seem inadequate. The oxidations of metals, sugar, starch, oxalic acid, arsenious oxide, etc., by nitric acid are all autocatalytic and are accelerated by nitrous acid. The action of nitric acid on metals like copper, silver, etc., is accelerated by ferrous or ferric salts, since these help in the formation of the active substance, nitrous acid. It seems certain that nitric acid is at first reduced to nitrous acid by bismuth, mercury, copper, silver, etc., and by ferrous sulphate, sugar and similar reducing agents, nitric oxide being formed in these reactions mainly by the decomposition of nitrous acid. In these cases nitrous acid or hyponitrous acid may be formed, but not hydroxylamine, hydrazine, or ammonia, which are obtained only by the action of metals such as zinc, magnesium, aluminium, iron, cadmium, etc.; the latter metals are able actually to hydrogenate nitric acid, whereas copper, bismuth, silver, mercury, etc., can only take away oxygen from nitric acid. T. H. P.

**1515.** *On the Time-Rates of Vaporisation and Chemical Changes on the Surface of Contact of Two Fluids.* **S. Sano.** (Japanese Journ. Phys. 3. 4–6. pp. 117–131, 1924. In English.)—This entirely mathematical paper presents a theory of the time-rate of chemical changes on the surface of separation of two fluid phases and also corrects some inaccuracies of the author's previous theory on the time-rate of vaporisation [Abstract 157 (1924).] The most important principle used is that the entropy of a system thermally insulated always increases for irreversible processes within the system, and while inadequate for a complete solution of the problem, nevertheless furnishes interesting results. H. H. Ho.

**1516.** *Effect of Diffusion on the Time-Rate of a Chemical Change.* **S. Sano.** (Japanese Journ. Phys. 3. 4–6. pp. 133–137, 1924. In English.)—This mathematical paper establishes that chemical change occurs in the sense that the sum of the free energy and the kinetic energy of diffusion of a small portion of the fluid decreases by the change, provided the temperature, volume, and the velocity of each constituent with respect to the centre of mass of the portion are supposed to be constant during the change. H. H. Ho.

**1517.** *The Critical Increment of Chemical Reactions.* **W. E. Garner.** (Phil. Mag. 49. pp. 463–465, Feb., 1925.)—The law of mass action is applied to a bimolecular reaction, account being taken of the possible momentary formation of complexes between the reacting molecules. It is shown that the activation energy of the reactants may be either greater or less than the Arrhenius constant, whence it follows that the critical increment of energy is not necessarily the same as the activation energy, and that the frequencies $\nu$ in $\Sigma h\nu$ calculated therefrom may not coincide with the actual absorption bands of the reactants. J. S. G. T.

**1518.** *The Production of Chemical Reactions in Compressors.* **M. Brutzkus.** (Comptes Rendus, 180. pp. 429–432, Feb. 9, 1925.)—In a previous paper (*ibid.*, pp. 199–201, Jan. 19, 1925) it has been shown that, from the point of view of chemical equilibrium, all reactions are carried out best in compressors. A Diesel engine, which in the case of many chemical reactions can be run by means of the energy of reaction, and in others can be driven by a motor, forms the most perfect existing compressor for a combustion reaction, and can be used for all other chemical reactions. The necessary substances can be introduced as fluids by previously vaporising or spraying them, as solids in the form of powder, or as previously compressed gases. If the number of molecules is increased in the reaction it should be carried on with constantly diminishing pressure, *i.e.* during expansion, as in the case of liquid combustibles; if the number of molecules decreases the reaction should take place during compression; if there is no change in the number of molecules the reaction can be carried out either during the compression or the expansion stroke. Exothermic reactions should take place with continuous cooling; if the reaction can take place during expansion the volume change will suffice for cooling; a jet of cold high-pressure gas may be introduced into the cylinder; a jet of suitable liquid such as water may be injected, and the evaporation will cause cooling; the walls of the cylinder may be cooled externally. Endothermic reactions should be carried out with continuous heating; the heat of compression will in some cases be sufficient for this purpose; the outside of the cylinder may be heated, or hot gas may be injected. The concentration may be varied by injecting different quantities of the materials into the cylinders. No catalyser is required; it is not necessary to use pure chemical substances; very high temperatures and very high pressures can be employed simultaneously; if large final pressures are not required the final temperatures can be made large by making the initial pressure much less than one atmosphere. A successful laboratory experiment gives at once an industrial process. H. N. A.

**1519.** *Refractometric Studies of Neutralisation.* **F. S. Hammett.** (Frank. Inst., J. 199. pp. 91–98, Jan., 1925.)—The refractive indices of mixtures of strong and weak mono-, di-, and tri-basic acids (hydrochloric, acetic, sulphuric, oxalic, phosphoric and citric) and strong mono-acidic bases (sodium and potassium hydroxides) are linear functions of the process of neutralisation when base is neutralised by acid. The generalisation that the refractive index is an additive function of the molecular concentration of substances in solution is thus extended to mixtures of chemically reacting compounds of this type, and the data obtained show that the resultant products change in concentration according to the law of arithmetical progression. The same is true for the neutralisation of strong and weak monobasic acids by strong mono-acidic base. The refractive indices of mixtures of di- and tri-basic acids and mono-acidic bases is not a linear function of the neutralisation when the acid is neutralised by the base. Hence the generalisation is not applicable to chemically reacting mixtures of this type, and the change in concentration of the resultant products does not follow a simple arithmetical progression law. T. H. P.

**1520.** *Development and Application of Initiating Explosives.* **B. Grotta.** (Indust. and Engin. Chem. 17. pp. 134–138, Feb., 1925.)—With the exception of black powder, all industrial explosives require for releasing their energy the action of a detonator containing a suitable initiating explosive, itself capable of initiation by mere ignition. Fulminate of mercury, which still remains at the present time the chief explosive of this type, was first applied by Nobel in 1864. Recent developments have related more to the introduction and improvement of exploders or "boosters" which are of an intermediate degree of sensitiveness and serve to transmit the detonation from the sensitive detonator to the highly inert high explosive. The disadvantage of fulminate as a detonating material is its susceptibility to deterioration by moisture and its property of losing its explosive character when subjected to high pressures. Advantages are obtained by the use of azides or salts of hydronitric acid, those of mercury and lead being most suitable. A defect with azides, however, is that they are not so easily ignitable as fulminate, and lead azide reacts with copper to give a dangerously sensitive compound. Proposals to overcome these defects consist in employing a mixture of lead azide and lead tetranitroresorcinate in an aluminium container or a mixture of mercurous azide and fulminate of mercury in a copper container. J. N. P.

**1521.** *Salts of Cupferron.* **(Miss) V. Auger, L. Lafontaine** and **C. Caspar.** (Comptes Rendus, 180. pp. 376–378, Feb. 2, 1925.)—Cupferron, nitrosophenyl hydroxylamine, is used in chemical analysis for certain difficult separations, *e.g.*, iron and copper from nickel, cobalt chromium and aluminium. The properties of other salts of cupferron were determined. The metals of the $H_2S$, $(NH_4)_2S$, the alkaline earth groups were precipitated by cupferron, and the composition of the salts determined. Details of decomposing points, melting-points, and solubilities are given. F. J. B.

**1522.** *Dissociation of Lead Carbonate.* **M. Centnerszwer, G. Falk** and **A. Awerbuch.** (Zeits. phys. Chem. 115. pp. 29–53, Feb., 1925.)—Artificial and natural lead carbonate, their dissociation measured dynamically. Recognition of the oxycarbonates $3PbO, 5PbCO_3$; $PbO, PbCO_3$; $2PbO, PbCO_3$. The dissociation pressures of normal lead carbonate and its products of decomposition measured dynamically and statically. A. D.

**1523.** *Colours, Stains, and Dyes.* **J. F. Thorpe.** (Roy. Inst., Proc. Advance Proof. Received April, 1925.)—In this paper the author deals in a simple way with the fundamental principles underlying the constitution and action of the main groups of dyes and stains. F. S. B.

**1524.** *Studies in Catalysis.* **H. W. Underwood, Jr.** (Nat. Acad. Sci., Proc. 11. pp. 78–80, Jan., 1925.)—This paper is a brief sketch of a study of stabilisers or negative catalysts undertaken with the hope of establishing the mechanism of negative catalysis and of ascertaining principles which might be of general use. The guiding principle in the work has been Taylor's theory that the so-called inhibitors function by formation of molecular compounds with the active molecules of the substance being preserved. On this basis inhibitors are true negative catalysts and not reagents. A remarkable parallel between molecular compound formation and negative catalysis appears to exist. Substances such as ethyl ether, phenol, resorcinol and benzene are stabilisers for chloroform, and in each case evidence of molecular compound formation is available, and none for chlorination. More than 25 compounds have been studied, and no really serious contradiction of the thesis found. The fading of

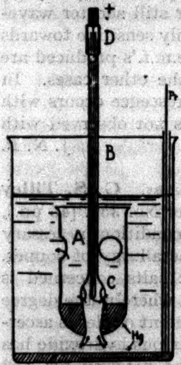
dyes is briefly discussed from the standpoint that some of the compounds which retard the decomposition of chloroform would also increase the fastness of certain colouring matters to light, a view which has received considerable experimental support by the use of phenol and resorcinol. Based on the view that dyes fast to light should contain groups similar to those found in stabilisers, the author has succeeded in obtaining from primuline (which usually is described as yielding somewhat fugitive developed colours) a series of brillaint azo dyes very fast to light.
H. H. Ho.

**1525.** *The Sensitiveness of Actinometers with Mercury Electrodes.* **G. Athanasiu.** (Comptes Rendus, 180. pp. 587–589, Feb. 23, 1925.)—By means of an electrochemical actinometer composed of electrodes of mercury halides or sulphides, which was described in an earlier publication [Abstract 1317 (1924)], a comparison is made over the range from 2500 to 5790 Å.U. of the e.m.f. produced by an exposure of one minute with the radiation energy as measured by a thermopile. It is found that the maximum sensitiveness of the actinometer is displaced towards the long wave-lengths with increasing atomic weight of the halogen. With mercurous iodide the maximum occurs at about 4046 Å.U., with a less marked increase at about 3000 Å.U. With mercurous bromide a well-marked maximum occurs at 2967 Å.U., while no measurable e.m.f. is produced with wave-lengths greater than 4064 Å.U. With mercurous chloride the actinometer commences to be sensitive with wave-lengths shortly beyond 3130 Å.U., and has a maximum at 2536 Å.U., or for still shorter wave-lengths. Mercurous chloride and bromide are thus only sensitive towards ultra-violet radiations. With mercury sulphide the e.m.f.'s produced are much feebler and of the opposite sign than with the other cases. In association with the light sensitiveness a visible fluorescence occurs with mercurous chloride and bromide, while the effect is not observed with the mercuric salts.
J. N. P.

**1526.** *The Purification of Copper Sulphate Solutions.* **G. S. Tilley** and **O. C. Ralston.** (Bureau of Mines, Techn. Paper No. 359. [45 pp.], 1924.)—A study is made on a commercial scale of the conditions necessary to effect the separation of impurities in the hydrometallurgy of copper. The hydrolytic behaviour of the different metallic salts concerned is investigated by means of a hydrogen or air electrode, whereby the degree of acidity which determines the separation of the different oxides is ascertained. The separation point of the ferrous ion as ferrous hydroxide has been estimated at $p\text{H} = 9$, and that of the ferric ion between $p\text{H} = 2$ and $p\text{H} = 3$. The point given for the maximum insolubility of aluminium hydrate varies according to different investigators from $p\text{H} = 6 \cdot 5$ to $p\text{H} = 8$. Copper is found to precipitate with alkali hydroxides at a point very close to neutrality when the air electrode is used as an indicator. Silicic acid is best precipitated by calcium hydroxide at $p\text{H} = 9$, and by aluminium hydroxide at $p\text{H} = 8$ to $8 \cdot 5$. Zinc, nickel, cobalt and manganese are precipitated at a higher alkalinity than copper. Ferrous ion lowers the current efficiency seriously in the electrodeposition of copper, and is the most troublesome impurity. Aluminium in amounts exceeding 4 % causes excessive foaming in electrolytic cells, but its presence in small amounts is desirable, as it reduces the corrosion of the copper kathodes by ferric iron. Ferrous iron in small amounts is advantageous in acting as depolariser of the anode and lowering the cell voltage. The lowering may amount to 0·8 volt for a ferrous iron content of 1·5 %. Details are given of a large number of trials in commercial practice on the precipitation of metallic oxides from copper solutions, the breaking up of colloid solutions, and the effect of different types of aerators. The hydrolytic agents which can be employed in practice are limited to carbonates and oxides of copper and calcium. J. N. P.

**1527.** *Electric Field of Ions and Neutral Salt Action.* **P. Debye** and **J. McAulay.** (Phys. Zeits. 26. pp. 22–29, Jan. 1, 1925.)—Strong electrolytes—distinguished by an accumulation of electrical charges due to their dissociation—not only present deviations from classical laws when pure, but also present " neutral salt actions " when mixed with non-electrolytes. These neutral salt actions, under conditions of equilibrium, present two types : (*a*) those which depend on the solvent (osmotic pressure, freezing-point, etc.) ; (*b*) those which depend on the concentration (mass-law, electromotive force, etc.). These actions are investigated, taking into account changes in the electric field of the ions and changes in the dielectric constant. The free energy is worked out and the activity of the non-electrolyte is determined. Particular cases are examined. A. D.

**1528.** *Anodic Purification of Mercury.* **E. Brummer** and **S. v. Náray-Szabó.** (Zeits. Elektrochem. 31. pp. 95–97, Feb., 1925.)—During electrolysis with a mercury anode, a platinum gauze kathode and an electrolyte of mercurous nitrate acidified with nitric acid, determinations are made at different periods of the composition of the anode and kathode mercury and the electrolyte. Analysis of the mercury is made by determining the specific gravity, the amount of residue after distillation, and the e.m.f. given by it when used in a standard calomel cell. The main impurity which accompanies the kathodically deposited mercury is zinc, while by far the purest mercury is that remaining at the anode after an electrolysis of two hours with a c.d. of 10–12 amps./dcm.$^2$. On account of the tendency for the separation of mercurous nitrate crystals at the anode a rotating anode is found preferable. The type devised is shown in the fig., and causes renewal of the electrolyte over the surface of the anode mercury by centrifugal action and by a circulatory action which occurs from below to above the anode surface. A c.d. of 50–60 amps./dcm.$^2$ is employed, and the impurity in the mercury is reduced by a two-stage treatment to 0·0003 %. J. N. P.



**1529.** *The Preparation of Electrolytic Mercurous Chloride in Saturated Potassium Chloride for Use in the Calomel Electrode.* **W. W. Ewing.** (Am. Chem. Soc., J. 47. pp. 301–305, Feb., 1925.)—A method of making electrolytic mercurous chloride directly in saturated potassium chloride is outlined, the advantages claimed being the obtaining of a dependable quality of calomel mixed with finely divided mercury, and the avoidance of tedious washing and shaking processes with the resultant uncertainties. The e.m.f. of the cell, Hg + HgCl, HgCl in saturated KCl, HgCl in N . KCl, HgCl + Hg is 0·0388 volt at 25°. The electrode potential of the saturated potassium chloride calomel half-cell is − 0·2446 volt at 25° on the hydrogen scale. The temperature coefficient of the saturated potassium chloride calomel half-cell is 0·0002 volt per deg. for the temp. range 20–30°. Full experimental details are included. H. H. Ho.

**1530.** *Electro-endosmosis. Part* 3. **F. Fairbrother** and **H. Mastin.** (Chem. Soc., J. 127. pp. 322–327, Feb., 1925.)—Further experimental determinations are carried out according to method employed in connection with previous papers [see Abstracts 1263 and 1264 (1925)]. The results, which are expressed in tabular form and in graphs, show that anions have comparatively little effect. The quadrivalent ferrocyanide ion appears to be slightly abnormal. Kations tend to annul, and then, in the case of ter- and quadri-valent ions, to reverse the sign of the charge of carborundum in water, which is originally negative. The effect becomes much more marked on passing from univalent K to bivalent Ba, and then to ter- and quadri-valent ions. Al (III) and Th (IV) give a maximum positive charge to carborundum at about N/4000, and produce an appreciable effect even at $5 \cdot 0 \times 10^{-6}$ N, the sign of the charge being reversed at $10^{-5}$ N. In very low concentrations of K salts, carborundum is more negative than in water. The results in general show great similarity to those of Kruyt for stream potentials in glass capillary tubes. A. B. C. L.

**1531.** *Theory of Electrolytic Conductivity.* **O. Redlich.** (Phys. Zeits. 26. pp. 199–205, Feb. 15, 1925.)—In the application of their theory of electrolysis to the conductivity of diluted aqueous solutions, Debye and Hückel [Abstracts 2328 and 2541 (1923)] had to calculate two constants for each salt. In the hope of extending the theory to non-aqueous solvents the author demonstrates in the first instance that for highly diluted aqueous solutions of monovalent salts it is sufficient to determine one constant, the hydrodynamic ionic radius. This calculation involves the modification of Stokes' law by the introduction of an empirical coefficient $\phi$, which can be deduced, for all monovalent salts, from the conductivity data of one salt; taking the values of Noyes and Falk and of Weiland for KCl, this $\phi$ is found to be 0·694. The author further considers also the second order term of the badly converging series of Debye and Hückel, and derives, with the aid of Ohm's law, a differential equation for the conductivity which, for the range up to 0·1 mol. per litre, is in good agreement with observations. H. B.

**1532.** *Deposition of Electrolytic Copper-Zinc Alloys from Cyanide Solutions.* **R. Carl.** (Zeits. Elektrochem. 31. pp. 70–84, Feb., 1925.)—Referring particularly to Spitzer [Abstract 1667 (1905)], the author studies the electrolytic deposition of brasses under technical conditions, even heating the baths, though that complicates the phenomena; he also stirs his baths contrary to practice. The anodes are always cast brass plates (70·3 Cu, 29·7 Zn); the electrolyte contains the potassium cyanides of the two metals in various proportions, KCN and further $Na_2SO_3$; all the solutions are pure. An addition of 3 gm. KCN per litre generally lowers the current efficiency by 10 to 20 %. The first deposit is always white. When the proportions of the two metals are the same in the anode and in the electrolyte, the deposit need not be of the same composition. When $p$ is the Cu percentage in the brass, $q$ the anodic current density, $z$ the kathodic density, $x$ the ratio Zn/Cu in the electrolyte, and $y$ the copper percentage in the deposit, then $y$ decreases with decreasing $z$, the curve being a hyperbolic parabola $y = z/(z + kx)$, provided that sufficient free KCN be present and the kathodic density $z$ below 90 %. The most favourable condition for the deposition of alloys of constant composition and colour is found to be $x = 1$. H. B.

**1533.** *On the Conditions of Precipitation, by Electrolytes, of Selenium Hydrosol and other Hydrosols.* **J. J. Doolan.** (J. Phys. Chem. 29. pp. 178–187, Feb., 1925.)—An investigation is made to determine whether in the precipitating effect of electrolytes on the hydrosols of selenium and tellurium, a discrepancy with the Schulze-Picton-Linder law is given as was found by Odén in the case of sulphur hydrosols. The colloid particles of the selenium hydrosol which was prepared by dialysis possess a negative charge. It is found necessary to protect the sols from light, as this causes a rapid precipitation apart from electrolyte action. The precipitating power of electrolytes for selenium sols increases with the valency, but the limiting concentrations of salts with cations of the same valency differ among themselves. In the case of tellurium sols, if the figures for sodium chloride, zinc sulphate, and aluminium sulphate be selected, the ratio 1 : 50 : 1000 results, which differs from the ratio $1 : x^2$ demanded by the Schulze law. In order to determine the applicability of this law to a given hydrosol it is considered necessary to define the concentration and size of particles and to maintain the temperature constant. In view of the principle of selective adsorption, and taking into account the probability of the second ion exerting a peptising effect, it is not thought possible that a simple law of the type of Schulze can cover all the factors of coagulation. J. N. P.

**1534.** *The Present Status of Applied Organic Electrochemistry.* **C. J. Thatcher.** (Am. Electrochem. Soc., Trans. 45. pp. 33–36, 1924.)—In the United States the application of electrochemical methods to the production of organic compounds seems to have been confined, principally, to the regeneration of spent chrome liquors resulting from the use of chromic acid mixtures in various organic oxidation reactions. During the war p. amidophenol was prepared electrolytically. It is stated that in Switzerland, benzidene is being manufactured commercially by an electrochemical process and that in Germany some of the larger chemical works are using electrochemical methods for the production of anthraquinone. J. N. P.